98F-0014

FINDING OF NO SIGNIFICANT IMPACT

FOR

Food Additive Petition 8A4568, submitted by Bio-Cide International Inc., to amend 21 *CFR* 173.325 to provide for the safe use of acidified solutions of sodium chlorite as an antimicrobial agent in water and ice that are used to rinse, wash, thaw, transport or store seafood in accordance with current industry standards of good manufacturing practice.

Environmental scientists within the Office of Premarket Approval, Center for Food Safety and Applied Nutrition, have determined that the approval of this petition will not significantly affect the quality of the human environment and, therefore, will not require the preparation of an environmental impact statement. This finding is based on information submitted by the petitioner in an environmental assessment (EA) prepared using the format described in 21 *CFR* 25.31a(a) of FDA's previous Part 25, and on the attached supplement to the EA.

Prepared by: Buzz L. Hoffmann for Date: June 28, 1999
Layla I. Batarseh, Ph.D., Team Leader
Chemistry and Environmental Review Team
Division of Product Policy

Approved by: Buzz L. Hoffmann Date: June 28, 1999
Buzz L. Hoffmann, Ph.D, Team Leader
Environmental Review Team
Division of Product Manufacture and Use

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Supplement to the Environmental Assessment for FAP 8A4568

This document incorporates by reference the petitioner's environmental assessment (EA) dated October 1, 1997, and its attachments.

The petitioner provided information on the environmental introductions, fate, and effects of the subject additive as a result of its use in land-based seafood processing operations or retail facilities. Based on this information, the petitioner concluded that there would be no significant impact on the environment as a result of approval of the proposed action. We concur with the petitioner's conclusions, with respect to land-based facilities. However, the petitioner did not address the possibility that the additive, acidified sodium chlorite, also might be used on board fishing vessels at sea. Such use might result in introductions of substances to the marine environment. We believe that any introductions of substances resulting from use of the additive will not have a significant impact on the marine environment for the following reasons:

1. Acidified sodium chlorite will be used at a level of 25 ppm (wt/wt). Upon acidification, about 20% of the additive will be converted to chlorine dioxide, the active antimicrobial ingredient. As explained in the petitioner's EA, chlorine dioxide is a strong oxidizing agent that will disappear upon reaction with inorganic and organic compounds. The remainder of the sodium chlorite and other acidification species also will undergo chemical reduction reactions that will significantly lower the concentrations entering the environment. Any remaining substances in the wastewater and ice discharged into the sea will be diluted many times once the wastewater enters and mixes with seawater.

2. FDA conferred with EPA on the application of its NPDES regulations under the Clean Water Act regarding this proposed use (Memorandum of Telephone Conversation dated June 9, 1999). The use and discharge of an antimicrobial agent from point sources in the United States are subject to the requirements of National Pollution Discharge Elimination System (NPDES) permits under the Clean Water Act (33 U.S.C. 1251 et seq.). Users of an antimicrobial agent such as acidified sodium chlorite must have a current NPDES permit in order to discharge effluent containing it into lakes, streams, ponds, estuaries, oceans, or other waters and must discharge it in accordance with the requirements of the NPDES permit. The user also must have notified the permitting authority in writing prior to the discharge of an effluent. These NPDES requirements apply to both land-based facilities and seafood processing facilities on vessels operating at sea

within the exclusive economic zone of the United States, i.e., 200 nautical miles from the U.S. shoreline. Specific permitting regulations for floating vessels are listed under 33 U.S.C. 1342.

3. Based on our review of the environmental fate and effects information in the EA and elsewhere in the petition, we believe that there are no extraordinary circumstances indicating that the proposed action will threaten a violation of the existing environmental laws and requirements described in 2, above.

Prepared by: _____ Date: June 28, 1999

Layla I. Batarseh, Ph.D.
Team Leader
Chemistry and Environmental Review Team
Division of Product Policy

ENVIRONMENTAL ASSESSMENT

1. ***Date:*** 10/1/98 Confirmed by the petitioner's letter dated 9/4/98.

2. ***Name of Applicant/Petitioner:***

   Bio-Cide International, Inc.

3. ***Address:***

   P.O. Box 722170
   Norman, OK 73070-8644

4. Description of the proposed action.

The proposed action of this petition is to obtain the permitted usage of acidified sodium chlorite for use as a secondary direct food additive in process water.

The proposed action is necessary to make acidified sodium chlorite available for use in the seafood processing and retailing industries as an antimicrobial agent for treatment of process water and ice. Acidified sodium chlorite has been demonstrated to be an effective antimicrobial agent for controlling bacteria in seafood process water and ice. The antimicrobial activity of acidified sodium chlorite is primarily due to the presence of chlorine dioxide a well known and widely used antimicrobial compound. The use of acidified sodium chlorite in seafood process water and ice will help to preclude contamination of seafood by spoilage and pathogenic bacteria. Due to its low toxicity, the use of acidified sodium chlorite in the treatment of process water and ice by seafood processors and retailers presents minimal risk to the user, consumer and the environment.

The source for sodium chlorite solution is OXINE which will be produced at the Bio-Cide production facility located at 2650 Venture Drive in Norman, Oklahoma. The production facility consists of two buildings and is located within NW 1/4 NE 1/4 SE 1/4 Section 11, Township N, Range W, IM, Cleveland County, Oklahoma. The facility has been located at this site and has been producing Oxine since 1976. The facility is located on approximately 2.5 acres and is owned by Bio-Cide International, Inc. The site is located in the Northport Business Park and is bordered to the west by Marqwear, Inc. a sportswear manufacturer, to the north by Briggs and Stratton, Inc., a small engine service center and to the east by the City of Norman Public Schools Maintenance Center. The park is zoned L-I for light industrial use and is located in rural, but developing area with a low population density.

The ecosystem of the production facility site is best described as a tall grass prairie near the general convergence of the post oak/black jack forest region and the western tall grass prairie. The indigenous flora is mostly blue stem, bermuda and gama grasses in association with native and introduced weeds, shrubs and a few scrub oak and black locust thickets. The fauna that are common to the area are cottontail rabbits, jack rabbits, skunks, opossums and a variety of rodent species. Indigenous reptiles may include various species of land turtles, terrapins, common lizards and various snake species. Birds include the local and migratory species common to the region including meadowlarks, bobwhite quail, sparrows, starlings, scissortail flycatchers, crows and so forth. Several raptor species such as hawks and are common in the area. Amphibians may include the common toad, leopard frog, and green frog. There are no bodies of water of sufficient size and permanence either on the site or immediately adjacent to which can support fish life. BLH(HFS-214) 3/3/99

Oxine will be marketed nationwide through a network of established distributors of commercial and industrial chemicals and by direct sales from Bio-Cide International, Inc.. Since seafood processing and retailing facilities are quite numerous and are found in nearly all areas of the country, it is impossible to describe all of the locations and types of environments present at the sites where Oxine will be used and disposed. Seafood processing sites are typically in coastal areas although production by aquaculture is also done in inland areas.

5. Identification of chemical substances that are the subject of the proposed action.

IDENTITY:

A. Trade name - Oxine

B. E.P.A. Registration Number: Oxine - 9804-1

The EPA registered active ingredient for the Oxine product is chlorine dioxide. Oxine exists as a sodium chlorite solution which produces chlorine dioxide upon acidification. A report on the chemical analysis for Oxine is enclosed at Item 15 - Appendices. The study was performed by Lancaster Laboratories of Lancaster, PA., an FDA registered laboratory. The following parameters were analytically determined and reported: (1) Total available chlorine dioxide (2) Sodium chlorite (3) Sodium chloride (4) Sodium hydroxide (5) Sodium carbonate and (6) pH. Additionally, determinations were performed for potentially harmful contaminants such as heavy metals. A total of five separate product lots were tested and included in the study report.

The concentrated Oxine product is a clear, colorless liquid with an extremely faint chlorine-like odor and a mild salty taste. The EPA registered active ingredient of Oxine is chlorine dioxide, a primary component of the acidified sodium chlorite solution. The Oxine concentrate contains 2.0% w/w or 20,000 ppm available ClO_2 as determined by the standard iodometric method for chlorine dioxide determination which can be found in The Standard Methods of Analysis of Water and Wastewater.

IDENTITY OF CHLORINE DIOXIDE

A. Common Name: Chlorine Dioxide

B. Chemical Abstract Service Registry Number (CAS): 10049-04-4

C. Chemical Name (CAS): Chlorine Dioxide

D. Empirical Formula: ClO_2

E. Structural Formula: O = Cl = O

F. Molecular Weight: 67.45

Chlorine dioxide has an oxidizing capacity which is about 2.63 times that of chlorine and it is this function as an oxidizing agent which makes it a very effective a_{n+1} microbial. Oxine has important applications in disinfection, sanitation and odor removal. In actual use, the Oxine concentrate is diluted to a working concentration of 25 ppm for the proposed usage in treating seafood processing water and 20 ppm for the proposed usage in treating ice used to store seafood.

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Other chlorine species which are found in the acidified Oxine solution and are important for

consideration are:

A. Sodium Chlorite, $NaClO_2$, CAS No. 7758-19-2

B. Sodium Chlorate, $NaClO_3$, CAS No. 7775-09-9

C. Sodium Chloride, NaCl, CAS No. 7647-14-5

Oxine is not an available chlorine product. Neither hypochlorous acid nor hypochlorite are present in Oxine.

Inert ingredients in Oxine include:

A. Sodium Carbonate, Na_2CO_3, CAS No. 497-19-83

B. Sodium Hydroxide, NaOH, CAS No. 1310-73-2

These chemical components are necessary for the formation of the stable equilibrium complex and for maintenance of proper pH which is in the mildly alkaline range of 8.0 - 8.5. The remainder of the Oxine solution is water.

The actual concentration of free ClO_2 in the Oxine concentrate is in the low ppm range. Activation of Oxine by lowering the pH in accordance with label instructions produces the acidified sodium chlorite solution of which chlorine dioxide is the species of principle efficacy. Citric acid ($C_6H_8O_7$, CAS No. 77-92-9) of food grade quality may be used for this activation procedure. Additionally, inorganic acids which are generally regarded as safe, such as phosphoric acid, (H_3PO_4, CAS No. 7664-38-2) may also be used for activation.

A Material Safety Data Sheet for Oxine is in Item 15, which provides additional physical/chemical specifications and handling considerations.

6. Introduction of substances into the environment:

A. Spent acid liquor: A liquid hazardous waste is generated from the manufacturing of Oxine. It is the spent acid solution from the ClO2 generators that contains approximately 35% sulfuric acid ($H2SO_4$). Approximately seven (7) to ten (10) thousand gallons of spent acid are produced annually. It is collected in a chemically inert tank for final processing and is neutralized before disposal. No more than 500 gallons are present at the facility at any one time.

   (I) Storage, treatment and discharge of the acid waste are done in strict accordance with City of Norman Industrial Discharge Permit No. NID014. This permit is authorized from May 15, 1995 through May 14, 1998. A copy of the discharge permit is included in Item 15. The spent acid material is neutralized on site and, thus is not considered to be a hazardous waste under EPA RCRA regulations.

(ii) The waste acid is treated immediately after being discharged from the scrubber tanks. Treatment involves neutralization of the acid by the addition of sodium hydroxide (NaOH). The treated waste is then discharged to the City of Norman municipal sanitary sewer collection and treatment system.

(iii) The quality of the treated waste discharge is highly regulated by provisions contained in the discharge permit. These are as follows:

Pollutant or Pollutant Property	Specific Pollutant Limitations (mg/L)
1. Lower pH	5.0 SU
2. Upper pH	12.0 SU
3. Temperature	40 degrees Celsius
4. Total Suspended Solids	**(Surcharge if above 150 ppm)
5. Arsenic	0.24
6. Cadmium	0.04
7. Chromium	1.40
8. Copper	1.42
9. Lead	0.43
10. Mercury	0.006
11. Nickel	3.09
12. Silver	0.08
13. Zinc	6.26

All treated waste is tested for compliance of proper pH and temperature prior to discharge. All other parameters are tested four times per year by grab sample. The metal analysis is performed by a laboratory certified by the Oklahoma Department of Environmental Quality and the City of Norman. The semiannual testing report and a sample chain of custody report are submitted to the City of Norman Industrial Pretreatment Program Coordinator. Records pertaining to all spent acid waste treatment monitoring are retained for a minimum of three (3) years. A copy of the "Waste Acid Neutralization/Discharge Batch Report" is enclosed in Item 15.

(iv) Currently, this method of treatment and disposal is the most economical and environmentally safe method for safe deposit of the waste acid. Compliance with the applicable requirements concerning the spent acid waste would be unaffected by approval of the proposed action. The spent acid will still be produced during the manufacture of Oxine and would still be treated and disposed of in accordance with the City of Norman Industrial Pretreatment Discharge Permit.

B. Air Emissions:

Bio-Cide International, Inc. was granted a facility operating permit on June 5, 1986, by the Air Quality Division of Oklahoma State Department of Health certifying compliance with all air emission requirements. The permit was granted after submission of an application containing detailed technical descriptions of all plant operations and an on-site inspection of the production facility. A copy of the operating permit is enclosed in Item 15. Approval of the petition would not alter the terms set forth for compliance with the facility operating permit.

The Occupational Safety and Health Administration permissible exposure level for chlorine dioxide is 0.1 ppm or 0.3 mg/m^3 as listed in 29 CFR 1910.1000. A copy is enclosed in Item 15. The potential for employee exposure to ClO_2 gas is very low due to following mitigating measures:

(1) Production of ClO_2 is done in a dedicated generator room with ventilation to the outside of the plant.

(2) Pressure equalization vents to the outside are down line from ClO_2 scrubbers and strippers to remove any ClO_2 gas prior to release of the air outside of the plant.

(3) Other than the pressure equalization vents, the ClO_2 generator system is open only to the absorber columns where the ClO_2 gas is totally converted to stabilized non-volatile species.

(4) The potential for worker exposure to free chlorine dioxide is very low if Oxine is used according to label instructions. The activation of Oxine and the conversion of the oxychlorine precursors to free ClO_2 are functions of pH and time. The label activation procedure carefully controls these two parameters to preclude the release of ClO_2 into the air of the working environment by the activated concentrate. At Item 15 is a copy of the report entitled, "Safety in the Workplace: Ambient Chlorine Dioxide Measurements in the Presence of Chlorine". This study shows that proper engineering control methods such as mechanical ventilation can adequately control the presence of chlorine dioxide in the work place atmosphere at acceptable levels. When diluted to the working solution concentration, the free ClO_2 is readily soluble and evolution of significant quantities of ClO_2 into the air would not be expected during use.

No burning of fossil fuels is necessary for the production of Oxine except to heat the plant during the cooler seasons.

C. Emission Substances from Use of Oxine.

When used in accordance with label instructions, the oxychlorine species associated with Oxine would undergo conversion to the chloride, Cl^-, prior to release into the environment.

Oxidation-reduction reactions of chlorine dioxide in water result in the formation of the chlorite ion according to the following reaction.

$$ClO_2 + e^- \rightarrow ClO_2^-$$

The chlorite ion is also an effective oxidizing agent and will be consumed through oxidation-reduction reactions with oxidizable and reducible material. These occur as follows:

$$ClO_2^- + 4\ H^+ + 4e^- \rightarrow Cl^- + 2\ H_2O$$

It is reported in the literature that under water treatment conditions approximately 50 - 70 percent of the chlorine dioxide reacted will immediately appear as chlorite and the remainder as chloride. The residual chlorite continues to degrade in reactions with oxidizable material in the distribution system and under these conditions, no chlorate is found.

Under wastewater treatment conditions, the amount of oxidizable material present would greatly exceed that present under drinking water treatment conditions and would insure the conversion of Oxine oxychloro species to chloride. Thus, chloride is the substance of eventual release into the environment from the use of Oxine, although minute quantities of chlorate may also be present.

The following, Item 7, contains illustrative reactions of oxychlorine species with oxidizable materials which typically would be expected to occur prior to release of acidified sodium chlorite into the environment. It will also contain illustration of the reactions involved in the fate of chlorine dioxide and other oxychloro species which would occur through an accidental release into the environment.

*7. **Fate of emitted substances in the environment.***

(A) Air: The chemical nature of Oxine, which has been previously described, precludes the emission of free chlorine dioxide into the air except under extreme circumstances. When performed in accordance with label instructions, the acidification of Oxine will produce free chlorine dioxide from the oxychlorine equilibrium complex. This may result in the volatilization of, at most, trace amounts of ClO_2 into the air. In a worst case scenario resulting from over-acidification or other misuse, a temporary slight excess of ClO_2 in the air over 0.1 ppm might occur. Chlorine dioxide in air readily undergoes photochemical decomposition. (1,2)

(B) Freshwater, marine and estuarine ecosystems: Chlorine dioxide and chlorite are the substances of environmental concern which might be released into aquatic environments through the use of Oxine. If used in accordance with the labeled instructions for the proposed use, the possibility of the release of toxic substances into aquatic environments in harmful quantities is remote. The Oxine containing process water and ice from a seafood processing operation or retailing facility would go to either the plant wastewater facility or to a municipal sewer for treatment prior to release. Chlorine dioxide and chlorite would both be eliminated through reactions with inorganic and organic compounds. The predominant chlorine form expected to eventually result from the various reactions is the chloride ion, Cl^-. Additionally, photochemical decomposition of ClO_2 and biodegradation of ClO_2 and chlorite would be expected. The large volumes of water and ice used in seafood processing and retailing would

also dilute the quantities of ClO_2 and chlorite to extremely low levels, even if the above reactions did not occur. Various reactions of ClO_2 and chlorite which are documented in the scientific literature are presented below.

(I) Reactions of ClO_2 and ClO_2^- with inorganic compounds:

(a) Reactions with ferrous iron and manganese: In aqueous solutions with pH below neutrality ClO_2 reacts with Fe^{+2} and Mn^{+2} with the oxidation of the divalent cation and reduction of ClO_2 to chloride. These reactions occur when iron and manganese are present in a reduced state or are coupled with organic compounds such as humic and fulvic acids. The acids, phenolic in nature, are oxidized. Stoichiometrically, the reaction of ClO_2 with ferrous iron is: (3)

$$ClO_2 + 4\,H^+ + 5\,Fe^{+2} \rightarrow 5\,Fe^{+3} + Cl^- + 4\,H_2O$$

Under alkaline conditions, where the chlorite ion might predominate, salts of ferrous iron and manganese are oxidized quantitatively by sodium chlorite. (4)

$$ClO_2^- + 4\,FeO \rightarrow 2\,Fe_2O_3 + Cl^-$$

(b) Reactions with sulfides: The formation and control of sulfides are a common problem in wastewater treatment. Sulfides will react with ClO_2 and ClO_2^-. The exact ~~reasons~~ reactions which would occur are dependent upon pH and other factors. The expected reactions are listed below:

$$2\,ClO_2 + 5\,H_2S \rightarrow 5\,S + 4\,H_2O + 2\,H^+ + 2\,Cl^-$$

$$ClO_2^- + H_2S \rightarrow SO_4^{+2} + 2\,H^+ + Cl^-$$

The efficacy of such reactions in H_2S control is illustrated by the fact that Bio-Cide International, Inc. is the owner of a patent for the use of aqueous chlorine dioxide based solutions for the control of hydrogen sulfide in drilling fluids (Patent No. 4,473,115). Other uses of such solutions for the control of H_2S in the petroleum industry are currently being investigated.

(c) Reactions with ammonia and amines: In wastewater containing ammonia and primary amines, no residual oxidants corresponding to chloramines are formed since ClO_2 does not react with ammonia and primary amines. (5)

(ii) Reactions with organic compounds:

In general, chlorine dioxide reacts with organic compounds by the addition of oxygen rather than by the addition of chlorine. This preference for the addition of oxygen to organic compounds is the principle reason that chlorine dioxide may become the disinfectant of choice for drinking water and wastewater treatment. For these uses,

the formation of trihalomethanes and other toxic or carcinogenic chlorinated organic compounds is significantly reduced or eliminated by the use of ClO_2 instead of Cl_2. The reactions of seafood and seafood microflora organic compounds with ClO_2 from Oxine are expected to be the same as those which occur from the ClO_2 treatment of drinking water and wastewater.

Chlorine dioxide readily reacts with phenols and phenolic compounds by the addition of oxygen and the breaking of the ring structure. Chlorine dioxide has been used for many years to control phenolic tastes and odors in drinking water. The use of ClO_2 for this purpose is widely publicized. (6)

The reactions of chlorine dioxide and chlorite with phenols and phenolic derivatives are numerous and complex due to the large number of phenolic compounds and due to the numerous mechanisms of oxidation. The following reaction scheme is shown to illustrate the reactions of ClO_2/ClO_2^- with lignin, a complex polyphenolic compound of plant origin. (7)

This example is meant to be illustrative and does not imply that all reactions of ClO_2 and ClO_2^- with phenolic compounds are of these types. Masschelein presents a good and readily available review of the reactions of ClO_2 and ClO_2^- with phenols and phenolic acid derivatives. (8)

The E.P.A. has reviewed a large body of literature concerning the reaction products of ClO_2 and ClO_2^- with organic compounds in the treatment of drinking water. They conclude that halogenation of organic compounds can occur with the use of ClO_2, but at rates considerably lower than for Cl_2. (9)

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Stevens concluded that organic halogen concentrations are significantly lower when ClO_2 is used as the disinfectant rather than Cl_2 when used to treat waters with naturally occurring organic compounds. Non-chlorinated products may also occur, such as quinones and epoxides. Inorganic compounds associated with the use of ClO_2 are chlorite, chlorate and chloride. (10)

Chlorine dioxide has been shown to react with and eliminate various pesticides, including products highly toxic to fish such as rotenone. (11) Chlorine dioxide has been shown to be the oxidant of choice for the removal of phenylamide pesticides from water. (12) Other pesticides which can be eliminated by reaction with ClO_2 are methoxychlor (DMDT) and aldrin. (13) Herbicides such as paraquat and diquat are oxidized by chlorine dioxide. (14) All of the above listed pesticides might be reasonably expected to be found in waters used to process seafood, to store seafood and on the surface of displayed seafood products.

The photolytic decomposition of chlorine dioxide also occurs in aqueous systems. The principle decomposition products are expected to be chlorate and chloride. (15)

Finally, enzymatic mechanisms for the bio-degradation of chlorite and chlorine dioxide have been shown to exist in eukaryotic systems. (16) Chloroperoxidase enzymes have been isolated which catalyze the dismutation of both chlorine dioxide and chlorite. The following molar ratios were observed for the reactions:

1 mole chlorine dioxide → 0.3 mole chloride,
0.7 mole chlorate, and
0.17 mole oxygen (O_2)

1 mole chlorite → 0.4 mole chloride,
0.6 mole chlorate, and
0.13 mole oxygen (O_2)

Other similar antioxidant mechanisms are known to exist which could provide a similar system for the biodegradation of chlorine dioxide and chlorite.

Terrestrial Ecosystems: The fate of Oxine released into a terrestrial ecosystem would be the rapid decomposition by the oxidation of organic material in the manner presented in (b) of the section.

8. Environmental effects of released substances:

For purpose of the Registration, Data Call-in and Re-registration program for pesticide products regulated under the Federal Insecticide, Fungicide and Rodentcide Act, the EPA has determined that the potential health and environmental effects for chlorine dioxide and chlorite are essentially identical. By letter of 21 April 1992, EPA notified Bio-Cide International, Inc. That data for sodium chlorite and chlorine dioxide would be mutually acceptable for ecological effects, environmental fate, toxicology and residue considerations. A copy of this letter is included in Item 15.

(A) Air

As previously stated, at most, only trace amounts of ClO_2 would be released into the air by the proposed usage. It is doubtful that any toxic concentration could be achieved under normal use. The OSHA TLV is 0.1 ppm as established by the American Congress of Government Industrial Hygienists.

Masschelein cites several studies on the effects of exposure in air of ClO_2 to laboratory test animals. These include: "The exposure of rats to 1.0 ppm ClO_2 for 5 hours/day, 5 days/week for two months, does not effect weight gain, leucocyte or erythrocyte counts or hepatic and pulmonary parenchyma. Rats and rabbits were exposed for 30 days to 2.5, 5.0 or 10.0 ppm ClO_2, respectively for 4 to 7 hours/day, 2 hours/day and 2 hours/day. Localized bronchopneumonia with elevated leucocyte counts was observed after exposures to 10 and 5 ppm, while only slight reversible pulmonary lesions were found after the 2.5 ppm exposure. Another study reports that two-to-four 15 minute exposures

to 5.0 ppm ClO_2 per day for one month did not alter the blood composition or lung histology of rats." (19)

We believe that no significant impact of the health of human beings or other organisms would occur by approval of the proposed usage. This is due to the extremely low potential for the release of significant quantities of ClO_2 into the air and due to the expected photochemical decomposition of ClO_2 in air.

(B) Aquatic and Terrestrial Ecosystems:

With the increased interest in the use of ClO_2 as a disinfectant for drinking water, much work has been done to determine the potential health effects of ClO_2, ClO_2^- and ClO_3^- on human populations. Since Oxine contains all of these oxychlorine species, toxicity studies from the literature are applicable in showing the very low potential toxicity of Oxine at recommended usage for concentrations and expected residuals.

The principal health concern for chlorine dioxide, chlorate and chlorite centers on the fact that very large doses of these oxidants can produce metheglobinema in test animals. Methemoglobinemia is an abnormal condition of the oxygen binding protein hemoglobin found in the erythrocytes. Hemoglobin consists of four polypeptide chains linked to a non-peptide prosthetic group called heme. Heme is an iron porphyrin complex and is the binding site for oxygen molecules. The iron atom in the heme can exist in either the ferrous (+2) or the ferric (+3) oxidation state. These corresponding forms are called ferroglobin and ferrihemoglobin, respectively. Only ferrohemoglobin, the +2 oxidation state, can bind oxygen. Therefore, persons with methemoglobinemia have a reduced capacity for blood transport of oxygen.

Certain human subpopulations may represent groups at higher risk to erythrocyte oxidant stress. The largest two groups are persons with lower G6PD activity and neonates. Glucose-6-phosphate dehydrogenase (G6PD) deficient cells have a reduced ability to produce NADPH via the pentose phosphate pathway and, consequently, produce less glutathione (GSH). Since glutathione is the primary mechanism of red blood cells defense against oxidant stress, persons with deficient G6PD levels have a reduced capacity for protection against oxidants. Neonates have a variety of deficiencies and differences in their blood cells that enhance their susceptibility to oxidant stress and methemoglobinemia.

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A large body of literature exists concerning toxicological studies on chlorine dioxide, chlorite and chlorate. Numerous researchers have performed a wide variety of testing, including acute toxicity, chronic toxicity, rising dose toxicity and epidemiological studies. A consistent pattern is observed that any toxic effects and alterations in hematological parameters are dose related and that significant changes occur only at chronically administered higher dosages (100 mg/l to 1,000 ml/l) in test animals or humans. The following literature citations are aimed at general evaluation of ClO_2, ClO_2^- and ClO_3^- toxicity and evaluations of increased risk potential to these populations with high oxidant stress susceptibility.

Calabrese, et. al., did a literature survey on the health effects of chlorine dioxide, "The Health Effects

of Chlorine Dioxide as a Disinfectant in Potable Water: A Literature Survey." They concluded that concentrations of chlorine dioxide at 10 mg/l is not considered a toxic agent in a variety of animals. At higher concentrations and chronic administration (≥ 100 mg/l), some animal models exhibited altered hematological parameters, usually at very high concentrations and apparently dose related. (18)

Lubbers, et al., conducted an extensive controlled clinical evaluation on the effects of ClO_2, ClO_2^- and ClO_3^- in man, "Controlled Clinical Evaluations of Chlorine Dioxide, chlorite and Chlorate in Man." This double blind study was conducted in three phases: (1) rising dose tolerance acute toxicity study; (2) Chronic studies at 5 mg/l and (3) Administration at 5.0 mg/1 to persons with G6PD deficiencies, ergo sensitive to oxidant stress. They concluded that no observable undesirable sequellae were noted by participating subjects or by the observing medical team. Any treatment associated trends were judged to be of no physiological consequence. (17)

Bercz, et al., examined the subchronic toxicity of $C10_2$, ClO_2^- and ClO_3^- in nonhuman primates, "Subchronic Toxicity of Chlorine Dioxide and Related Compounds in Drinking Water in the Nonhuman Primate." Concentrations rose from 0 to 400 mg/1 over the test period. The only significant toxic effect was elicited by $C10_2$, which inhibited thyroid metabolism at 100 mg/1. This effect was unexplained and, indeed, was considered paradoxical, since $C10_2$ is rapidly reduced by oral and gastric secretions, they presume, to $C1^-$. They concluded that it is unlikely that absorption of a simple chlorine oxide species caused the thyroid effect. (20)

Moore and Calabrese examined the effects of $C10_2$, $C10_2^-$ and $N0_2^-$, on mice with G6PD deficiencies. Their study hypothesis was that $C10_2$, and $C10_2^-$ would exhibit significant toxic effects on an animal population with erythrocytes susceptible to oxidant stress, "Effect of Chlorine Dioxide, Chlorite and Nitrate on Mice with Low and High Level of Glucose-6-Phosphate Dehydrogenase (G6PD) in Their Erythrocytes." They found no significant effects on sensitive mice at concentrations of 10 Ppm. Again, any physiological effects were dose related and were deemed significant only at 100 Ppm $C10_2^-$. No adverse additive or synergistic effects were observed between $C10_2^-$ and $N0_2^-$ when administered concurrently. (21)

A rising dose tolerance study was performed by Lubbers, et. al., as reported in "Effects of the Acute Rising Dose Administration of Chlorine Dioxide, Chlorate and Chlorite to Healthy Adult Male Volunteers." The study was undertaken to assess the relative safety and tolerance of the acute administration of $C10_2$ and its by-products, $C10_2^-$ and $C10_3^-$ to healthy male volunteers. Evaluation of an extensive battery of tests and vital signs showed no adverse physiological effects. (22)

Lubbers, et al., also examined the effects of chronic administration of $C10_2$ and its by-products on a healthy adult population in, "The effects of chronic Administration of Chlorine Dioxide, Chlorite and Chlorate to Normal Healthy Adult Male volunteers." A daily dose (500 ml, 5.0 ppm) was administered to the volunteers for a twelve week period. An analysis of the qualitative and quantitative parameters of an extensive body of tests showed no clinically important physiological effects. (23)

Lubbers, et. al., also examined the effects of chronic administration of chlorite to a susceptible

population as reported in, "The Effects of Chronic Administration of Chlorite to Glucose-6-Phosphate Dehydrogenase Deficient Healthy Adult Male Volunteers." The test subjects were administered daily doses (500 ml, 5.0 ppm $C10_2^-$) for twelve weeks. An evaluation of an extensive battery of tests designed to measure the bio-chemical and physiological response to chlorite ingestion detected no significant changes. (24) In, "Evaluation of Chemicals Used for Drinking Water Disinfection for Production of Chromosomal Damage and Sperm-head Abnormalities in Mice," Meier, et. al., determined that chlorine as hypochlorite and hypochlorous acid at 4.0 to 8.0 mg/kg dosages induced significant increases in the level of sperm-head abnormalities. Other disinfectants, including chlorine dioxide, sodium chlorite and sodium chlorate gave no evidence of any such effects. (25)

Suh, et. al., conducted a study to determine the effect of $C10_2$ and its metabolites on the formation of chloroform in rats. Male rats were administered 0, 10, 100 mg/1 $C10_2$ or 1, 10 mg/ $C10_2^-$ and $C10_3^-$ daily for one year in drinking water. Blood chloroform levels were significantly decreased in the $C10_2$ group at 2, 10 and 12 month treatment. Chlorite and chlorate groups showed similar decreases in blood chloroform concentration after one year. Chlorine dioxide at 5 mg/1 inhibited the formation of chloroform by HOC1 (5, 10, 20 mg/1) and sodium citrate at 1.0 mg/l (26)

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BJH HFS-246 6/24/99

Michael, et. al., conducted an epidemiological study on the effects of $C10_2$ in drinking water on the population of a rural town. They study compared a population of 178 persons exposed for three months to water with a chlorite concentration of about 5.0 Ppm to an unexposed population of 118 people. Data analysis failed to find any exposure related effects. This was reported in "Chlorine Dioxide Water Disinfection: A Prospective Epidemiology Study." (27)

Harrington, et. al., conducted a developmental toxicity study to determine the teratogenic effects of sodium chlorite on rabbits. The study concluded no maternal or fetal effects at 200 Ppm Na $C10_2$. (28)

Another review article concerning the application of $C10_2$ to water treatment concluded that available studies suggested no adverse health risks for both chlorine dioxide and chlorite at concentrations used in drinking water treatment. (29)

A review of the literature provides no evidence of significant human health risks for $C10_2$, $C10_2^-$ and $C10_3^-$ at concentrations below 10 ppm. As previously stated, the amounts of Oxine which would be released into the environment would be well below 10 ppm. Oxine has E.P.A. approval for use in stored potable water treatment at 5.0 ppm and is considered safe for human consumption at this concentration.

The International Research Agency for Research on Cancer (IARC) has assigned a Class 3 rating to sodium chlorite- "Not Classified As To Its Carcinogenicity To Humans." This is published in Vol. 52 of the IARC series. (30)

There was little information found in the literature concerning the potential effects of $C10_2$, $C10_2^-$ and $C10_3^-$ on non-mammalian species. However, data was found concerning the toxicity of oxychlorine species to representatives of the Classes Osteichthys, Aves and Insecta; these are reported below.

BLH HFS-246 3/3/99

The acute toxicity of sodium chlorite to bluegill and rainbow trout was reported in, "Acute Toxicity of Sodium Chlorite to Bluegill (Lepomis machrchirus) and Rainbow Trough (Salmo gairdneri)." The TL50 for bluegill was determined to be 208 mg/1 and to be 50.6 mg/1 for rainbow trout. (31) BLH HMS-246 3/3/99

The acute oral LD50 of sodium chlorite to Bobwhite Quail is reported in, "Acute Oral Toxicity Study with Sodium Chlorite in Bobwhite Quail." The reported LD50 of $NaC10_2$ in quail was 660 mg/kg. (32)

Calandra reported the LD50 of sodium chlorite in mallard ducks to be 1000 mg/kg in, "Acute Oral Toxicity Study with Sodium Chlorite in Mallard Ducks." (33)

The toxic effects of a stabilized chlorine dioxide solution on honey bees was reported by Lackett in, "Oxodene: Longevity of Honey Bees." It was found that concentrations of 10 and 100 ppm chlorine dioxide in sucrose significantly lengthened the life times of the tested honey bees. Higher concentrations reduced longevity with all test bees fed 10,000 ppm $C10_2$ dying within a week. (34)

The release of Oxine into terrestrial ecosystems would have minimal effects. Chlorine dioxide reaching the ground would quickly react and decompose according to the chemical reactions and physical mechanisms which have been previously discussed. No threat to groundwater would be anticipated. Bio-accumulation would not occur in either plants or animals.

The data available strongly suggests that the amounts of the oxychlorine species which would be expected to be released into the environment through use and disposal would be so low as to pose no threat to either aquatic or terrestrial ecosystems.

No potential adverse environmental impacts were determined by E.P.A. in its review of Oxine for registration under FIFRA. E.P.A. requires no warning label for the toxicity of Oxine to organisms in the receiving environments.

9. Uses of Resources and Energy

(A.) Land Use:

The land used for the production of Oxine is a fixed factor and includes the 2.5 acre site on which the Bio-Cide production facility is located. Land use for the production of Oxine would be unaffected by the proposed action. The proposed action would have no impact on land usage at seafood processing and retailing sites. This disposal of Oxine for the proposed action would have no impact on land use, as it would normally be disposed of through existing wastewater treatment facilities, either on site or through municipal treatment facilities. The disposal of Oxine containers would usually be done at municipal or commercial landfills and would have little impact on land use.

(B.) Minerals:

Water is the only mineral resource of significant concern associated with the production and use of

Oxine. It is estimated that approximately 10 - 12 gallons of water are consumed for each gallon of Oxine produced. Approximately eighty percent (80%) of this water is used to cool the ClO_2 generators. The cooling water is drained to the sewer system. The proposed usage of Oxine requires the use of water as diluent for the Oxine concentrate. No additional water use is required for the disposal of Oxine since it would be disposed of through existing water treatment facilities.

(C.) Energy Use:

Calculated and estimated values for the energy used in the production, transport and use/disposal per gallon of Oxine are given below.

The costs of energy used in the production of Oxine were calculated based on energy consumption and rates from period, June-September, 1995. The cost of electricity used for the production of Oxine is approximately $.0526 per gallon.

The cost of the energy used to transport a gallon of Oxine is based upon: (1) the average gross shipping weight of Oxine equals 9.25 pounds per gallon; (2) the average shipping cost for the continental United States is $.88 per gallon; and (3) the average fuel allowance factor used by the trucking companies is 2.5% of the total cost. Therefore, the average cost of energy used for the transportation of Oxine is $.88 per gallon times 0.025 equals $0.022 per gallon.

The average costs of energy for use and disposal of Oxine are estimated to be no more than $0.01 and $0.05 per gallon respectively. The total estimated energy costs for the production, transportation and use/disposal of Oxine are estimated to be approximately $0.148 per gallon.

(D.) Endangered and Threatened Species

There are no anticipated effects on endangered or threatened species from either the production or use of Oxine. A copy of "Oklahoma's Endangered Species," published by the Oklahoma Department of Wildlife Conservation, is enclosed at Item 15 and lists endangered and threatened species in Oklahoma. Of the species listed species only the Interior Least Tern is known to regularly habit Cleveland County and nests only on sand bars of the Canadian River which is about five miles from the production facility. Whooping cranes and bald eagle are rare transients and have been known to range in the county. The use of Oxine would have no anticipated effects on any endangered or threatened species. The disposal of Oxine would present no anticipated effects on any threatened or endangered species.

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3/3/99

(E.) Historical Sites

There are no anticipated effects on any sites listed or eligible for listing in the National Register of Historic Places, from either the production or use of Oxine. Enclosed at Item 15 are the relevant portions of the "Oklahoma's National Register Handbook," published in December, 1996 by the Oklahoma Historic Preservation Office. This document contains a county by county listing of all sites in Oklahoma listed in the National Register of Historic Places. The nearest site to the Bio-Cide production facility is the Norman Historic district, located at 105 W. Main and 100 to 232 E. Main.

This site is approximately four (4) miles from the production facility and would be unaffected by the proposed action. There are no anticipated impacts on historic sites from either the use or disposal of Oxine.

10. Mitigation Measures

Not Applicable.

11. Alternatives to the Proposed Action

Not Applicable.

12. ***List of Preparers:***

Preparer: James P. Ringo
Vice President Technical Operations
Bio-Cide International, Inc.

Persons and Agencies Consulted:

Ken Raymond
Industrial & Solid Waste Division
Oklahoma State Department of Health

Glen Diehl
Air Quality Service Division
Oklahoma State Department of Health

Joyce Sheedy
Air Quality Service Division
Oklahoma State Department of Health

Ron Suttles
Oklahoma State Department of Wildlife Conservation

C. Earl Metcalf
State Historical Preservation Officer
Oklahoma Historical Society

Barry Pokorney
Texo Corporation

James Brown
Occupational Safety and Health Administration
U.S. Department of Labor

Neeraj Khanna, Ph.D.
Staff Chemist
Bio-Cide International, Inc.

James P. Ringo

Vice President Technical Operations
Bio-Cide International, Inc.
Norman, Oklahoma 73072

Education: M.S. Microbiology, University of Oklahoma 1980.

B.S. Zoology, University of Oklahoma 1976.

Professional Experience:

Environmental Specialist: Industrial and Solid Waste Division
Oklahoma State Department of Health

Duties included development of hazardous waste disposal plans. Development of Oklahoma Underground Injection Well program. Monitoring of waste disposal sites and industry compliance.

Environmental Planner: Oklahoma Department of Pollution Control.

Managed Oklahoma 208 Water Quality Management Program. Coordinated responses to pollution events with responsible state agencies. Managed public participation programs. Reviewed environmental impact statements.

Research Associate: Southwest Resources Engineering

Investigated the use of immobilized cell systems for the production of industrial solvents such as ethanol, acetone, butanol by fermentation.

13. ***Certification:***

The undersigned official certifies that the information presented is true, accurate, and complete to the best knowledge of Bio-Cide Internatonal, Inc.

October 20, 1997

James P. Ringo
Vice President Technical Operations

Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

LLI Sample No. UO 2456693
Collected:

Submitted: 2/ 2/96 Reported: 2/29/96
Discard: 3/21/96

Lot #9510-89 OXINE Sample

Account No: 09048
Bio-Cide International, Inc.
2845 Broce Drive
Norman, OK 73072

P.O. 297873
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0395	Arsenic	< 0.05	0.05	ppm
0396	Cadmium	< 0.2	0.2	ppm
0401	Lead	< 0.4	0.4	ppm
0404	Mercury	< 0.008	0.008	ppm
9001	Total Avail. Chlorine Dioxide	See Attached		
9002	Residual Solvent(GC Headspace)	See Attached		
9003	AWWA Method/Det.T.Na Chlorite	See Attached		
9004	AWWA Method/Det.NaChloride Con	See Attached		
9005	AWWA Method/Det.Na Hydroxide	See Attached		
9006	AWWA Method/Na Carbonate Con.	See Attached		
9007	pH	See Attached		

1 COPY TO Bio-Cide International, Inc. ATTN: Mr. Jim Rugo

Questions? Contact your Client Services Representative
Kathleen Hallquist at (717) 656-2300
10:43:25 D 0001 5 0 124224 502371
235 250.00 00156400 RAW172

Respectfully Submitted
Denise Legall, M.S.
Chemist IV/Coordinator

MEMBER ACIL
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2425 New Holland Pike
PO Box 12425
Lancaster, PA 17605-2425
717-656-2300 Fax 717-656-2681

Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

Raw Materials Analysis Report

Bio-Cide International, Inc.

Sample No.: 2456693

Lot #9510-89 OXINE Sample

Analysis	Specification	Result
Total Avail. Chlorine Dioxide	None supplied	1.94%
Residual Solvent(GC Headspace)	None supplied	469 ppm(1)
AWWA Method/Det.T.Na Chlorite	None supplied	2.17%
AWWA Method/Det.NaChloride	None supplied	0.29%
AWWA Method/Det.Na Hydroxide	None supplied	0.00%
AWWA Method/Na Carbonate	None supplied	0.00%
pH	None supplied	8.36

Notebook Reference:
13585 pp. 62-63; 14032 pp. 30-41.

Comments:
(1) Methanol value is uncorrected for background.

Method Reference:
Bio-Cide Method 001; American Water Works Association, AWWA B303-88, section 4.
USP 23 pp. 1746-1747, 2697-2698

Entered by: Tara L Seiple Date: 2/28/96

Checked by: D. Scott Montagna Date: 2-28-96

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MEMBER ACIL

000516

Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

LLI Sample No. UO 2456694
Collected:

Submitted: 2/ 2/96 Reported: 2/29/96
Discard: 3/21/96

Lot #9601-04 OXINE Sample

Account No: 09048
Bio-Cide International, Inc.
2845 Broce Drive
Norman, OK 73072

P.O. 297873
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0395	Arsenic	< 0.05	0.05	ppm
0396	Cadmium	< 0.2	0.2	ppm
0401	Lead	< 0.4	0.4	ppm
0404	Mercury	0.010	0.008	ppm
9001	Total Avail. Chlorine Dioxide	See Attached		
9002	Residual Solvent(GC Headspace)	See Attached		
9003	AWWA Method/Det.T.Na Chlorite	See Attached		
9004	AWWA Method/Det.NaChloride Con	See Attached		
9005	AWWA Method/Det.Na Hydroxide	See Attached		
9006	AWWA Method/Na Carbonate Con.	See Attached		
9007	pH	See Attached		

1 COPY TO Bio-Cide International, Inc. ATTN: Mr. Jim Rugo

Questions? Contact your Client Services Representative
Kathleen Hallquist at (717) 656-2300
10:44:20 D 0001 5 0 124224 502371
235 0.00 00131400 RAW172

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Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

Raw Materials Analysis Report

Bio-Cide International, Inc.

Sample No.: **2456694**

Lot #9601-04 OXINE Sample

Analysis	Specification	Result
Total Avail. Chlorine Dioxide	None supplied	1.98%
Residual Solvent(GC Headspace)	None supplied	537 ppm(1)
AWWA Method/Det.T.Na Chlorite	None supplied	2.17%
AWWA Method/Det.NaChloride	None supplied	0.40%
AWWA Method/Det.Na Hydroxide	None supplied	0.00%
AWWA Method/Na Carbonate	None supplied	0.00%
pH	None supplied	8.33

Notebook Reference:
13585 pp. 62-63; 14032 pp. 30-41.

Comments:
(1) Methanol value is uncorrected for background.

Method Reference:
Bio-Cide Method 001; American Water Works Association, AWWA B303-88, section 4.
USP 23 pp. 1746-1747, 2697-2698

Entered by: Tara L Seple Date: 2/28/96

Checked by: D. Scott Mintzer Date: 2-28-96

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Raw Materials Analysis Report

Bio-Cide International, Inc.

Sample No.: 2456695

Lot #9601-05 OXINE Sample

Analysis	Specification	Result
Total Avail. Chlorine Dioxide	None supplied	1.92%
Residual Solvent(GC Headspace)	None supplied	551 ppm(1)
AWWA Method/Det.T.Na Chlorite	None supplied	2.18%
AWWA Method/Det.NaChloride	None supplied	0.35%
AWWA Method/Det.Na Hydroxide	None supplied	0.00%
AWWA Method/Na Carbonate	None supplied	0.00%
pH	None supplied	8.30

Notebook Reference:
13585 pp. 62-63; 14032 pp. 30-41.

Comments:
(1) Methanol value is uncorrected for background.

Method Reference:
Bio-Cide Method 001; American Water Works Association, AWWA B303-88, section 4.
USP 23 pp. 1746-1747, 2697-2698

Entered by: Tara L Seiple Date: 2/28/96

Checked by: D. Scott Mylinger Date: 2-28-96

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See reverse side for explanation of symbols and abbreviations.

Analysis Report

Lancaster Laboratories
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LLI Sample No. UO 2456695
Collected:

Submitted: 2/ 2/96 Reported: 2/29/96
Discard: 3/21/96

Lot #9601-05 OXINE Sample

Account No: 09048
Bio-Cide International, Inc.
2845 Broce Drive
Norman, OK 73072

P.O. 297873
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0395	Arsenic	< 0.05	0.05	ppm
0396	Cadmium	< 0.2	0.2	ppm
0401	Lead	< 0.4	0.4	ppm
0404	Mercury	< 0.008	0.008	ppm
9001	Total Avail. Chlorine Dioxide	See Attached		
9002	Residual Solvent(GC Headspace)	See Attached		
9003	AWWA Method/Det.T.Na Chlorite	See Attached		
9004	AWWA Method/Det.NaChloride Con	See Attached		
9005	AWWA Method/Det.Na Hydroxide	See Attached		
9006	AWWA Method/Na Carbonate Con.	See Attached		
9007	pH	See Attached		

1 COPY TO Bio-Cide International, Inc. ATTN: Mr. Jim Rugo

Questions? Contact your Client Services Representative
Kathleen Hallquist at (717) 656-2300
10:44:34 D 0001 5 0 124224 502371
235 0.00 00131400 RAW172

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Lancaster Laboratories
A Thermo Analytical Laboratory

Raw Materials Analysis Report

Bio-Cide International, Inc.

Sample No.: 2456696

Lot #9601-07 OXINE Sample

Analysis	Specification	Result
Total Avail. Chlorine Dioxide	None supplied	1.98%
Residual Solvent(GC Headspace)	None supplied	550 ppm(1)
AWWA Method/Det.T.Na Chlorite	None supplied	2.18%
AWWA Method/Det.NaChloride	None supplied	0.36%
AWWA Method/Det.Na Hydroxide	None supplied	0.00%
AWWA Method/Na Carbonate	None supplied	0.00%
pH	None supplied	8.44

Notebook Reference:
13585 pp. 62-63; 14032 pp. 30-41.

Comments:
(1) Methanol value is uncorrected for background.

Method Reference:
Bio-Cide Method 001; American Water Works Association, AWWA B303-88, section 4.
USP 23 pp. 1746-1747, 26997-2698

Entered by: Tara L Seiple Date: 2/28/96

Checked by: D. Frost Mitchell Date: 2-28-96

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Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

LLI Sample No. UO 2456696
Collected:

Submitted: 2/ 2/96 Reported: 2/29/96
Discard: 3/21/96

Lot #9601-07 OXINE Sample

Account No: 09048
Bio-Cide International, Inc.
2845 Broce Drive
Norman, OK 73072

P.O. 297873
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0395	Arsenic	< 0.05	0.05	ppm
0396	Cadmium	< 0.2	0.2	ppm
0401	Lead	< 0.4	0.4	ppm
0404	Mercury	< 0.008	0.008	ppm
9001	Total Avail. Chlorine Dioxide	See Attached		
9002	Residual Solvent(GC Headspace)	See Attached		
9003	AWWA Method/Det.T.Na Chlorite	See Attached		
9004	AWWA Method/Det.NaChloride Con	See Attached		
9005	AWWA Method/Det.Na Hydroxide	See Attached		
9006	AWWA Method/Na Carbonate Con.	See Attached		
9007	pH	See Attached		

1 COPY TO Bio-Cide International, Inc. ATTN: Mr. Jim Rugo

Questions? Contact your Client Services Representative
Kathleen Hallquist at (717) 656-2300
10:44:48 D 0001 5 0 124224 502371
235 0.00 00131400 RAW172

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000522

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Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

Raw Materials Analysis Report

Bio-Cide International, Inc.

Sample No.: **2456697**

Lot #9601-08 OXINE Sample

Analysis	Specification	Result
Total Avail. Chlorine Dioxide	None supplied	2.05%
Residual Solvent(GC Headspace)	None supplied	532 ppm(1)
AWWA Method/Det.T.Na Chlorite	None supplied	2.19%
AWWA Method/Det.NaChloride	None supplied	0.36%
AWWA Method/Det.Na Hydroxide	None supplied	0.00%
AWWA Method/Na Carbonate	None supplied	0.00%
pH	None supplied	8.43

Notebook Reference:
13585 pp. 62-63; 14032 pp. 30-41.

Comments:
(1) Methanol value is uncorrected for background.

Method Reference:
Bio-Cide Method 001; American Water Works Association, AWWA B303-88, section 4.
USP 23 pp. 1746-1747, 2697-2698

Entered by: Tara L Seip Date: 2/28/96

Checked by: D. Frost Mahon Date: 2-28-96

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000523

Analysis Report

Lancaster Laboratories
A Thermo Analytical Laboratory

LLI Sample No. U0 2456697
Collected:

Submitted: 2/ 2/96 Reported: 2/29/96
Discard: 3/21/96

Lot #9601-08 OXINE Sample

Account No: 09048
Bio-Cide International, Inc.
2845 Broce Drive
Norman, OK 73072

P.O. 297873
Rel.

CAT NO.	ANALYSIS NAME	AS RECEIVED RESULTS	LIMIT OF QUANTITATION	UNITS
0395	Arsenic	< 0.05	0.05	ppm
0396	Cadmium	< 0.2	0.2	ppm
0401	Lead	< 0.4	0.4	ppm
0404	Mercury	< 0.008	0.008	ppm
9001	Total Avail. Chlorine Dioxide	See Attached		
9002	Residual Solvent(GC Headspace)	See Attached		
9003	AWWA Method/Det.T.Na Chlorite	See Attached		
9004	AWWA Method/Det.NaChloride Con	See Attached		
9005	AWWA Method/Det.Na Hydroxide	See Attached		
9006	AWWA Method/Na Carbonate Con.	See Attached		
9007	pH	See Attached		

1 COPY TO Bio-Cide International, Inc. ATTN: Mr. Jim Rugo

Questions? Contact your Client Services Representative
Kathleen Hallquist at (717) 656-2300
10:45:11 D 0001 5 0 124224 502371
235 0.00 00131400 RAW172

Respectfully Submitted
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Lancaster, PA 17605-2425
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See reverse side for explanation of symbols and abbreviations

BIO-CIDE INTERNATIONAL, INC.
2845 Broce Drive
Norman, Oklahoma 73072 U.S.A
(405) 329-5556
Fax: (405) 329-2681

PRODUCT: **Oxine®**

MATERIAL SAFETY DATA SHEET

TRANSPORTATION EMERGENCY 24 HOUR TELEPHONE: (800) 424-9300 (CHEMTREC)

SECTION I: PRODUCT IDENTIFICATION

PRODUCT NAME: **Oxine®**

CHEMICAL FAMILY: Mixture of Oxychlorine Compounds

SYNONYMS: N/A **CAS #:** None (Mixture)

NFPA RATING: [with 0 for no hazard to 4 for life threatening]
Fire: 0 **Health:** 1 **Reactivity:** 1 **Special:** None

WARNING STATEMENT: Product may cause eye and skin irritation

EPA REGISTRATION NUMBER: 9804-1

REVISION DATE: July 12, 1995
SUPERSEDES: June 1994

SECTION II: HAZARDOUS INGREDIENTS

INGREDIENT [CAS #]

	PERCENT	OSHA PEL	ACGIH TLV	STEL	OTHER
Sodium Chlorite [7758-19-2]	3.35 Minimum	NE	NE	NE	Irritant
Chlorine Dioxide [10049-04-4]	Trace	0.1 PPM	0.1 PPM	0.3 PPM	SARA 313
TOTAL	3.35				

NE = NOT ESTABLISHED NL = NOT LISTED
(C) = IDENTIFIED AS A CARCINOGEN BY OSHA, IARC, NTP, OR ROTECS

This document is prepared pursuant to the OSHA Hazard Communication Standard (29 CFR 1910.1200). In addition, other substances not classified as "Hazardous" per this OSHA Standard may be listed. The identity of other ingredients will be made available as provided in this standard.

SECTION III: PHYSICAL/CHEMICAL DATA

APPEARANCE AND ODOR: Clear liquid with very faint chlorinous odor

BOILING POINT: 213°F (100.5°C)
MELTING POINT: N/A

VAPOR PRESSURE: 23.7 mm Hg (25°C)
VAPOR DENSITY: 0.02 kg/m^3

SPECIFIC GRAVITY: 1.03 g/ml (20°C)

VOLATILE ORGANIC COMPOUNDS: <0.1% by weight

OCTANOL/WATER PARTITION COEFFICIENT: NE

EVAPORATION RATE: Comparable to Water
SOLUBILITY IN WATER: Complete
pH, CONCENTRATE: 8.0 to 8.5

OTHER DISTINGUISHING CHARACTERISTICS: N/A

SECTION IV: FIRE AND EXPLOSIVE HAZARD INFORMATION

FLASH POINT: None to solution boiling point.
Method: N/A

FLAMMABLE LIMITS (% By Volume):
Lower: N/A **Upper:** N/A

AUTOIGNITION TEMPERATURE: N/E

DECOMPOSITION TEMPERATURE: N/E (For dry sodium chlorite: 180 - 200°C)

FIRE EXTINGUISHING MEDIA: Water unless contraindicated by other material involved in fire.

FIRE-FIGHTING EQUIPMENT: Standard protective gear with self-contained breathing apparatus.

SPECIAL FIRE-FIGHTING PROCEDURES: Do not allow **Oxine®** solutions to evaporate to dryness. If chlorine dioxide gas is produced, vent to atmosphere. Open or vent any large containers of **Oxine®**.

UNUSUAL FIRE OR EXPLOSIVE HAZARDS: The sodium chlorite in dried **Oxine®** is a strong oxidizer, which supports combustion. Chlorine dioxide, which may evolve from **Oxine®** solutions, is explosive in the gaseous phase at concentrations greater than 10% by volume. Do not allow chlorine dioxide gas to accumulate within a confined space.

SECTION V: REACTIVITY DATA

STABILITY: Product is stable.

CONDITIONS TO AVOID: Avoid storing product under conditions in which it could evaporate to crystalline salt.

INCOMPATIBLE MATERIALS: Avoid accidental contact with acids, chlorine compounds, hypochlorites (bleach), sulfur and sulfite compounds, phosphorus, organic solvents, and combustible/flammable materials.

HAZARDOUS DECOMPOSITION PRODUCTS: Exposure to acids or chlorine compounds can produce uncontrolled generation of chlorine dioxide gas.

HAZARDOUS POLYMERIZATION: Does not occur.

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SECTION VI: HEALTH HAZARD DATA

INGESTION: Rat Oral LD 50: 4,360 mg/kg. Ingestion may produce gastric discomfort, nausea, vomiting, and diarrhea. Intake of large quantities may produce methemoglobinemia.

EYE CONTACT: Based on rabbit studies, **Oxine®** has been given an EPA Category III rating as a mild irritant. Exposure can produce slight irritation of conjunctiva, cornea, and eyelid.

SKIN CONTACT: Based on rabbit studies, **Oxine®** is listed as "practically not an irritant". Prolonged exposure may produce localized irritation, contact dermatitis, mild erythema, and edema.

SKIN ABSORPTION: Highly unlikely to be absorbed through skin in toxic amounts. Rabbit Acute Dermal LD 50 > 2,020 mg/kg.

INHALATION: Acute Inhalation: LC 50 > 5.61 mg/l. Prolonged inhalation of fog or mist containing **Oxine®** may be irritating to nose and throat.

SYSTEMIC AND OTHER EFFECTS: None known.

CHRONIC EXPOSURE EFFECTS: May cause localized irritation to as exposed to product.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Skin disorders, such as dermal allergies and dermatitis. Exposure to chlorine dioxide produced by activation can aggravate pulmonary disorders, such as emphysema.

CARCINOGENICITY: Active ingredients are not listed by ROTECS, OSHA, IARC, or NTP. No evidence to date implicating product as carcinogen or tumor promoter.

MUTAGENICITY: Though product active ingredient is a chemical oxidant, no evidence to date for mutagenicity from whole animal or in vitro studies.

REPRODUCTIVE EFFECTS: No known effects to date.

OTHER HEALTH HAZARDS/HEALTH EFFECTS: None known.

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SECTION VII: FIRST AID

TARGET ORGANS: Skin, eyes. For chlorine dioxide produced from activation: respiratory tract and exposed mucous membranes.

SYMPTOMS OF OVER-EXPOSURE: Skin and eye irritation. Exposure to chlorine dioxide from activation can produce coughing, sore throat, headache, and dizziness.

FIRST AID

SKIN CONTACT: Wash affected area thoroughly with soap and water. Remove contaminated clothing and rinse thoroughly with water before laundering or discard. If irritation occurs, seek medical attention.

EYE CONTACT: Flush eyes thoroughly with water, making certain eyelids are held open. If irritation or burning persist, seek medical attention.

INHALATION: Unactivated **Oxine®** normally has no respiratory effects. If exposure to chlorine dioxide produced from activation occurs, remove victim to fresh air. Contact a physician if respiratory distress continues.

INGESTION: DO NOT INDUCE VOMITING. Contact a physician or Poison Control Center immediately.

PLEASE NOTE: Above procedures are recommended as emergency first aid precautions only. They are not intended to replace or supplant the treatment advice of a physician or other authorized health care specialist.

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SECTION VIII: CONTROL MEASURES/PERSONAL PROTECTION EQUIPMENT

VENTILATION: Open air or good room ventilation is normally adequate for safe use of this product. Avoid breathing any vapors or fumes resulting from acid activation.

RESPIRATORY PROTECTION: In accordance with OSHA regulations (29 CFR 1910.134 and 29 CFR 1910.1000), fogging or spraying applications may require worker respiratory protection, such as: (1) NIOSH/MSHA approved air-purifying respirators, or (2) NIOSH/MSHA approved canister/cartridge facial respirators rated for chlorine/acid vapors or specified for chlorine dioxide.

EYE PROTECTION: Good manufacturing practice recommends use of chemical safety goggles for all applications involving chemical handling.

PROTECTIVE CLOTHING: Good manufacturing practice recommends that, at a minimum, rubber, neoprene, or other chemically impervious gloves be worn for all applications involving chemical handling.

OTHER PROTECTIVE MEASURES: Product should be stored and applied in close proximity to a safety shower, chemical eyewash station, or other fresh water source.

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SECTION IX: SPILL, LEAK, AND DISPOSAL PROCEDURES

ENVIRONMENTAL NOTIFICATION: All spills and leaks involving more than 10 gallons should be reported to the nearest regional EPA office or designated state emergency response office within 24 hours. Spills from ocean vessels or which may contaminate U.S. coastal waterways should be reported to the nearest Coast Guard office within 24 hours.

SPILL OR LEAK PROCEDURE: Small spills, involving less than 10 gallons, may be flushed to a designated and permitted sewer system with copious amounts of water. Larger spills should be contained and neutralized with sodium bisulfite or sodium thiosulfate (1.2 lbs neutralizer for each estimated lb. of spilled material) or disposed of as chemical waste in the manner indicated below. The vicinity of the spill should be thoroughly flushed with water after clean-up. At no time should the spilled material be allowed to dry to a crystalline salt. Do not discharge this product to storm drains or to any surface or groundwater source unless specifically allowed under a valid NPDES permit.

DISPOSAL PROCEDURE: Small quantities, less than 10 gallons, may be flushed to an authorized and permitted sewer with copious amounts of water. Larger volumes should be taken to an authorized chemical disposal site (Class I or landfill) in accordance with all federal, state, and local regulations. Consult with selected facility regarding the need for prior neutralization of waste.

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SECTION X: SPECIAL PRECAUTIONS

PRODUCT STORAGE: Store in a cool, dry, well-ventilated location away from acids, chlorine and chlorine compounds, hypochlorites (bleach), organic solvents, sulfur and sulfite compounds, phosphorus, combustible/flammable materials, and direct sunlight. Keep containers tightly closed when not in use and open carefully to prevent spillage. Storage on wooden floors and pallets is not recommended.

PRODUCT HANDLING: Use product only as directed by the label or by your authorized Bio-Cide representative. Avoid contact with skin and eyes; avoid breathing any vapors or fumes resulting from product activation. Wash thoroughly after handling. Thoroughly rinse all protective gear and handling equipment, such as transfer pumps and lines, with water prior to reuse or storage. Keep away from children, animals, and unauthorized personnel.

OTHER PRECAUTIONS: Product may bleach clothing and fabric materials, such as draperies and carpets.

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SECTION XI: REGULATORY STATUS

Federal EPA Regulations

TSCA: All product ingredients are on inventory.

SARA TITLE 312/313: Neither the product nor its constituent ingredients are listed under SARA reporting requirements. Chlorine dioxide produced from activation is listed under SARA 313.

FIFRA: **Oxine®** is an EPA registered sanitizer (EPA No. 9804-1)

RCRA: Not considered a hazardous waste either categorically or by chemical listing.

CLEAN WATER ACT: Neither product nor constituent ingredients is listed as priority pollutant.

CLEAN AIR ACT: Neither product nor constituent ingredients is listed as priority pollutant.

Federal OSHA Regulations

Neither product nor constituent ingredients is classified as an acute or chronic health hazard by OSHA. Chlorine dioxide produced by activation is regulated with an air exposure limit of 0.1 ppm TLV and 0.3 ppm STEL.

Federal Department of Transportation

Not regulated.

State Laws

CALIFORNIA: Not regulated under the provisions of Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986).

NEW JERSEY: Sodium Chlorite is listed under New Jersey's Chemical Inventory Notification Requirement (NJAC 7:1Z). Estimated release notification, however, is not required.

PLEASE NOTE: Regulatory requirements are subject to change and may vary from one location to another. It is the users responsibility to ensure compliance with all applicable federal, state, and local regulations pertaining to the purchase, transport, storage, use, and disposal of this product.

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The information contained in this Material Safety Data Sheet has been assembled by the manufacturer, based on its own studies and on research accomplished by others. The manufacturer gives this information without warranty, expressed or implied. The information contained herein is accurate as of the date posted, to the best knowledge of the manufacturer.

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INDUSTRY (PERMITTEE): Bio-Cide International, Inc.

CONTACT OFFICIAL: James P. Ringo

ADDRESS: 2650 Venture Drive
Norman, OK 73069

Received from the City of Norman, Industrial Pretreatment Discharge Permit No. NID014 .

Accepted By:

James P. Ringo
Company Representative

15 May 1995
Date

000528

CITY OF NORMAN

INDUSTRIAL DISCHARGE PERMIT

INDUSTRY (permittee): Bio-Cide International, Inc.

CONTACT OFFICIAL: James P.Ringo

ADDRESS: 2650 Venture Drive
Norman, OK 73069

PERMIT NO: NID014

The above identified permittee is authorized to discharge wastewater to the municipal wastewater collection and treatment system, pursuant to the provisions of this permit.

Authorization is granted for a period beginning May 15, 1995 through May 14, 1998.

James P. Ringo
Authorized Representative

15 May 1994
Date

C V. P.
Title

James P. Ringo
Signature

000529

A. EFFLUENT LIMITATIONS

The quality of the permittee's industrial discharge will be limited by the provisions of the Norman Industrial Regulation set forth in the Municipal Ordinance Section 10-402 and in the National Pretreatment Regulations which include, but are not limited to, the following numerical limitations:

Pollutant or Pollutant Property	Specific Pollutant Limitations mg/L
1. Lower pH	5.0 SU
2. Upper pH	12.0 SU
3. Temperature	40° C
4. Total Suspended Solids	**
5. Arsenic	0.24
6. Cadmium	0.04
7. Chromium	1.40
8. Copper	1.42
9. Lead	0.43
10. Mercury	0.006
11. Nickel	3.09
12. Silver	0.08
13. Zinc	6.26

**Permittee will be subject to a surcharge for discharge of extra strength wastewater for these parameters. Extra strength wastewater is defined as wastewater having a biochemical oxygen demand greater than 200 mg/L, a total suspended solids content greater than 150 mg/l, and/or a Total Kjeldahl Nitrogen content greater than 30 mg/L.

Note: All metal analysis shall be for Total Metals not dissolved metals.

B. PROHIBITIONS

1. General discharge prohibitions. No user shall contribute or cause to be contributed, directly or indirectly, any pollutant or wastewater which will cause Pass Through or Interference of the operations or performance of the POTW. These general prohibitions apply to all such users of a POTW, whether or not the user is subject to national categorical pretreatment standards or any other national, state or local pretreatment standards or requirements. A user shall not contribute the following substances to any POTW:

a. Pollutants which by reason of their nature or quantity are, or may be, sufficient either alone or by interaction with other substances create a fire or explosion hazard or be injurious in any other way to the POTW or to the operation of the POTW, including, but not limited to, waste streams with a closed cup flashpoint of less than 140 degrees Fahrenheit or 60 degrees Centrigade using the test methods specified in 40 CFR 261.21. Prohibited materials include, but are not limited to, gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides, and any other substances which the City, the state or EPA has notified the user is a fire hazard or a hazard to the system.

b. Solid or viscous substances, which may cause obstruction to the flow in a sewer or other interference with the operation of the wastewater treatment facilities, such as, but not limited to: grease, garbage with particles greater than one-half inch in any dimensions, animal guts or tissues, paunch manure, bones, hair, hides, or fleshings, entrails, whole blood, feathers, ashes, cinders, sand, spent lime, stone, or marble dust, metal, glass, straw, shavings, grass clippings, rags, spent grains, spent hops, waste paper, wood, plastics, gas, tar, asphalt residues, residues from refining or processing of fuel or lubricating oil, mud, or glass grinding or polishing wastes;

c. Any wastewater having a pH less than 5.0, or having any other corrosive property capable of causing damage or hazard to structures, equipment and/or personnel of the POTW;

d. Any wastewater containing toxic pollutants in sufficient, quantity, either singly or by interaction with other pollutants, which will injure or interfere with any wastewater treatment process, constitute a hazard to humans or animals, create a toxic effect in the receiving waters of the POTW, or exceed the limitation set forth in a categorical pretreatment standard. A toxic pollutant shall include, but not limited to, any pollutant identified pursuant to Section 307 (a) of the Clean Water Act;

e. Any noxious or malodorous liquids, gases or solids which, either singly or by interaction with other wastes, are sufficient to create a public nuisance or hazard to life or are sufficient to prevent entry into the sewers for maintenance and repair;

f. Any substance which may cause the POTW's effluent or any other product of the POTW, such as residues, sludges or scums, to be unsuitable for reclamation and reuse or to interfere with the reclamation process. In no case shall a substance discharged to the POTW cause the POTW to be in noncompliance with sludge use or disposal criteria, guidelines or regulations developed under Section 405 of the Act; any criteria, guidelines or regulations affecting sludge use or disposal developed pursuant to the Solid Waste Disposal Act, the Clean Air Act, the Toxic Substances Control Act or state criteria applicable to the sludge management method being used;

g. Any substance which will cause the POTW to violate its NPDES and/or state disposal system permit or the receiving water quality standards;

h. Any wastewater with objectionable color not removed in the treatment process, such as, but not limited to, dye wastes and vegetable tanning solutions;

i. Heat in amounts which will inhibit biological activity in the POTW resulting in Interference, but in no case heat in such quantities that the temperature at the POTW Treatment Plant exceeds 40 °C (104 °F) unless the Approval Authority, upon request of the POTW, approves alternate temperature limits.

j. Any pollutants, including oxygen demanding pollutants (BOD, etc.) released in a Discharge at a flow rate and/or pollutant concentration which will cause Interference with the POTW. In no case shall a slug load have a flow rate or contain concentration or qualities of pollutants that exceed for any time period longer than fifteen (15) minutes more than five (5) times the average twenty-four (24) hour concentration, quantities or flow during normal operation;

k. Any wastewater containing any radioactive wastes or isotopes of such halflife or concentration as may exceed limits established by the Control Authority in compliance with applicable state or federal regulations;

l. Any wastewater which causes a hazard to human life or creates a public nuisance;

m. Any trucked or hauled pollutants, except at discharge points designated by the POTW;

n. Petroleum oil, nonbiodegradable cutting oil, or products of mineral oil origin in amounts that will cause interference or pass through.

o. Pollutants which result in the presence of toxic gases, vapors, or fumes within the POTW in a quantity that may cause acute worker health and safety problems.

2. Federal categorical pretreatment standards. Upon the promulgation of the federal categorical pretreatment standards for a particular industrial subcategory, the federal standard, if more stringent than limitations imposed under this article for sources in that subcategory, shall supersede the limitations imposed under this article. The Control Authority shall notify all affected users of the applicable reporting requirements under 40 CFR, Section 403.12.

3. Specific pollutant limitations. No person shall discharge wastewater containing in excess of:

Arsenic	0.24 mg/l
Cadmium	0.04 mg/l

Chromium	1.40 mg/l
Copper	1.42 mg/l
Cyanide	0.51 mg/l
Lead	0.43 mg/l
Mercury	0.006 mg/l
Nickel	3.09 mg/l
Silver	0.080 mg/l
Zinc	6.26 mg/l
BOD	*
TSS	*
TKN	*
Oil and Grease	400 mg/l
Total Toxic Organics	2.13 mg/l
Lower pH	5.0 SU
Upper pH	12.0 SU
Temperature	40 ° C

*BOD, TSS, and TKN are surchargable parameters. Surcharge is based on anything above 200 mg/l for BOD, 150 mg/l TSS, and/or 30 mg/l TKN.

All metal analysis shall be for Total Metals.

The above limits apply at the point where the wastewater is discharged to the POTW.

C. MONITORING AND REPORTING

1. Permittee shall collect representative samples of the wastewater discharge and analyze these waters for the pollutants indicated on the report form in Permit Attachment III. Where feasible, samples shall be obtained using flow proportional composite sampling techniques. Where composite sampling is not feasible, or inappropriate, grab sampling is acceptable.

   NOTE: Any laboratory performing analytical work for permittee must be Oklahoma Department of Environmental Quality certified for the parameters tested or receive prior written approval from the Industrial Pretreatment Program Coordinator before data will be accepted.

   NOTE: If permittee is unable to perform or contract with an approved laboratory to comply with the monitoring requirements, the City will perform required analyses and bill permittee for the direct cost of such analytical work.

2. Permittee shall summarize monitoring information on a copy of the attached Permit Attachment

III. A separate form will be completed and submitted for each sampling event required under the terms of this permit.

3. All reporting (including written notifications, oral notification, and monitoring reports) required by this permit shall, unless otherwise specified, be made to:

City of Norman
Industrial Pretreatment Program Coordinator
P.O. Box 370
Norman, OK 73070
(405) 329-2647

4. All sampling, sample preservation and analysis shall be done in accordance to the most current 40 CFR Part 136.

5. Failure to submit any report or information required by this permit shall constitute a violation of the permit.

6. The permittee shall give notice to the Industrial Pretreatment Program Coordinator 90 days prior to any facility expansion, production increase, or process modifications which results in new or substantially increased discharges or a change in the nature of the discharge. Modification to the permit may then be made to reflect any necessary effluent limitations for any pollutants not identified and limited herein.

7. This permit is not transferable to companies or processes other than those to which it is originally issued.

8. Permittee shall immediately notify the treatment plant at 321-6802 in the event of an operational failure of pretreatment equipment, accidental spill, or slug discharge of pollutants.

9. Permittee must maintain records of all information resulting from all monitoring activities, for a minimum period of three (3) years. These records will be made available for inspection and copying by the City or its authorized agent(s).

10. The monitoring and reporting schedule is provided in Permit Attachment I.

11. A Compliance Schedule is provided in Permit Attachment II.

12. The standard results report form is provided as Permit Attachment III.

13. The standard sampling record and chain of custody form to be employed is provided in Permit Attachment IV.

14. Each sampling report must be accompanied by the Permit Attachment III, Permit Attachment IV and the laboratory analysis. The laboratory analysis shall include results, analyst, sample type, time and date of analysis, EPA method number, and appropriate QA/QC.

15. The emergency reporting procedures for accidental spills or discharges of substances controlled under the terms of the industrial permit are provided in Permit Attachment V.

16. The permittee shall allow the Industrial Pretreatment Program Coordinator, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

    a. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

    b. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

    c. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit;

    d. Sample or monitor, for the purposes of assuring permit compliance, any substances or parameters at any location; and

    e. Inspect any production, manufacturing, fabricating, or storage area where pollutants, regulated under the permit, could originate, be stored, or be discharged to the sewer system.

17. Bypass of treatment facilities is prohibited unless it is unavoidable to prevent loss of life, personal injury, or severe property damage or no feasible alternatives exist.

18. A list of all industrial users which were considered in significant noncompliance as contained in 40 CFR Part 403.8(f) shall be annually published by the City of Norman in the largest daily newspaper within its service area.

19. Nothing in this permit shall be construed to relieve the permittee from civil and/or criminal penalties for noncompliance under Local, State or Federal laws or regulations.

20. In addition to civil and criminal liability, the permittee violating any of the provisions of this permit or causing damage to or inhibiting the City of Norman wastewater disposal system shall be liable to the City of Norman for any expense, loss, or damage caused by such violation or discharge. The City of Norman shall bill the permittee for the costs incurred by the City of Norman for any cleaning, repair, or replacement work caused by the violation or discharge. Refusal to pay the assessed costs shall constitute a separate violation.

D. GENERAL CONDITIONS AND DEFINITIONS

1. Severability

The provisions of this permit are severable, and if any provisions of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder if this permit, shall not be affected thereby.

2. Duty to comply

The permittee must comply with all conditions of this permit. Failure to comply with the requirements of this permit may be grounds for administrative action, or enforcement proceedings including civil or criminal penalties.

3. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact to the ~~public~~ treatment facilities or the environment resulting from noncompliance with this permit, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

4. Permit Modification

This permit may be modified for good causes including, but not limited to, the following:

a. To incorporate any new or revised Federal, State, or local pretreatment standards or requirements

b. Material or substantial alterations or additions to the discharger's operation processes, or discharge volume or character which were not considered in drafting the effective permit

c. A change in any condition in either the industrial user or the POTW that requires either a temporary or permanent reduction or elimination of the authorized discharge

d. Information indicating that the permitted discharge poses a threat to the Control Authority's collection and treatment systems, POTW personnel or the receiving waters

e. Violations of any terms or conditions of the permit

f. Misrepresentation or failure to disclose fully all relevant facts in the permit application or in any required reporting

g. Revision of or a grant of variance from such categorical standards pursuant to 40 CFR 403.13; or

h. To correct typographical or other errors in the permit

i. To reflect transfer of the facility ownership and/or operation to a new owner/operator.

j. Upon request of the permittee, provided such request does not create a violation of any applicable requirements, standards, laws, or rules and regulations.

The filing of a request by the permittee for a permit modification, revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

5. Permit Termination

This permit may be terminated for good reasons including, but not limited to, the following;:

a. Falsifying self-monitoring reports

b. Tampering with monitoring equipment

c. Refusing to allow timely access to the facility premises and records

d. Failure to meet effluent limitations

e. Failure to pay fines

f. Failure to pay sewer charges

g. Failure to meet compliance schedules.

6. Dilution

The permittee shall not increase the use of potable or process water or, in any way, attempt to dilute an effluent as a partial or complete substitute for adequate treatment to achieve compliance with the limitations contained in this permit.

7. Definitions

a. Bypass - Means the intentional diversion of wastes from any portion of a treatment facility.

b. Composite sample - A sample that is collected over time, formed either by continuous

sampling or by mixing discrete samples. The sample may be composited either as a time composite sample or as a flow proportional composite sample.

c. Grab sample - A sample which is taken from a waste stream on a one-time basis with no regard to the flow in the waste stream not exceeding 15 minutes.

d. Upset - Means an exceptional incident in which there is unintentional and temporary noncompliance with technology-based permit effluent limitations because of factors beyond the reasonable control of the permittee, excluding such factors as operational error, improperly designed or inadequate treatment facilities, or improper operation and maintenance or lack thereof.

CITY OF NORMAN

Debra Smith
Authorized Representative

5-9-95
Date

Industrial Pretreatment Coordinator
Title

Debra Smith
Signature

PERMIT ATTACHMENT I

Company: Bio-Cide International Inc. Permit No. NID014

Monitoring and Reporting Schedule:

Monitoring samples shall be collected at the waste sulfuric acid tank after neutralization with sodium hydroxide and before discharge to the sanitary sewer. Samples shall be grab samples since this is a batch discharge.

Sampling Point:

The sampling point shall be at the waste sulfuric acid discharge line.

Sampling Frequency and Analysis:

PH and temperature shall be monitored with each batch. All other parameters shall be monitored semiannually during the months of April and October at the specified sampling points and analyzed for the following parameters; arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc and total suspended solids. Samples shall be representative of discharge.

If sampling frequency is more than required by this permit, the results of those samples shall also be reported to the City of Norman.

Sampling Period:

Sampling Period(s) shall end on the last day of the month and the report(s) shall be submitted no later than the 15th day of the following month.

PERMIT ATTACHMENT II

Company: Bio-Cide International, Inc. Permit No. NID014

Compliance Schedule

None

PERMIT ATTACHMENT III

CITY OF NORMAN INDUSTRIAL PRETREATMENT PROGRAM

REPORT FORM

Permit Number	Monitoring Period	S.I.C.Number
NID014		2842

Please fill in all the blanks and submit the original report to the Industrial Pretreatment Program Coordinator.

Major contributing facility:

a) Name of firm: Bio-Cide International, Inc.

b) Street address: 2650 Venture Drive

c) City, state, zip, and county: Norman, OK 73069 (Cleveland)

Name, address, and phone number of laboratory performing analysis:

Were samples collected by the laboratory also? Yes No If no, list collector(s).

Sampling date and time:

Sampling location: Waste Sulfuric Acid Tank Discharge

Sample ID Number:

Characteristics of wastewater:

Parameter	As	Cd	Cr	Cu	Pb	Hg	Ni	Ag	Zn
Limit*	0.24	0.04	1.40	1.42	0.43	0.006	3.09	0.08	6.26
Sample Value									
Sample Code									

Parameter	+ pH	++ TSS	*** Temp
Limit*	**	150	40.
Sample Value			
Sample Codes			

Sample Codes:

U = Unscheduled

S = Scheduled

FCx = Flow Proportional Composite (x = hours)

Cx = Composite (x = hours)

G = Grab

* All values expressed in mg/l unless otherwise noted.
** Expressed in standard units
*** Expressed in centigrade
\+ Between 5.0 and 12.0 SU.
++ Surcharge is applicable to values in excess of the limit

If more than the required number of samples are analyzed, the additional results must also be reported.

I do hereby certify the above to be correct to the best of my knowledge.

PERMIT ATTACHMENT IV

CHAIN OF CUSTODY

INDUSTRIAL PRETREATMENT PROGRAM SAMPLING RECORD

Sample Date_____
Industry Name_____
Person(s) collecting sample_____
Sample Location_____
_____

Sample Type: Grab_____ Composite_____
If composite describe collection method, interval, duration, number bottles, volume, sample aliquot frequency and size, etc.
_____
_____

Sample Preservation_____
_____
_____

Sample Identification Marking_____
Was sample split with Facility? yes_____ no_____
Facility Representative_____

Observation comments - sample appearance, ambient conditions, special problems, etc._____
_____
_____

FIELD ANALYSES PERFORMED

Time	pH	Temp	Instrument or method used for Analysis
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Chain of Custody Relinquished By	Received By	Date	Time
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Disposition of Sample	Signature	Date	Time
_____	_____	_____	_____

PERMIT ATTACHMENT VII

Emergency Reporting Procedures

If your firm experiences an accidental spill or discharge of substances controlled under the terms of the industrial permit, please follow the procedures listed below.

Call 321-6802 immediately and report the following:

1. Your name, company name, and official for subsequent contacts.
2. Nature of mishap being reported.
3. List of known and suspected substances discharged.
4. Approximate volume discharged to (a) environment and (b) sewer.
5. Containment procedures underway.
6. Other agencies (fire, police, etc.) notified.
7. Written Notice: Within five (5) days following an accidental discharge, the user shall submit to the Industrial Pretreatment Coordinator, Wastewater Treatment Division, a detailed written report describing the cause of the discharge and the measures to be taken by the user to prevent future occurrences. Such notification shall not relieve the user of any expense, loss, damage or other liability which may be incurred as a result of damage to the POTW, fish kills, or any other damage to person or property; nor shall such notification relieve the user of any fines, civil penalties, or other liability which may be imposed by this article or other applicable law.

WASTE ACID NEUTRALIZATION/
DISCHARGE BATCH REPORT

In accordance with the provisions of the City of Norman, Industrial Pretreatment Permit No. NID014, the following parameters will be monitored and recorded for each batch of waste acid neutralized and discharged to the sanitary sewer system.

I. Date: _____

II. Volume of Waste Acid: _____GALLONS

III. Volume of Water: _____GALLONS

IV. Volume of 25% Sodium Hydroxide _____GALLONS

V. Total Volume of Waste Discharged _____GALLONS

VI. pH Neutralized Waste (must be in range pH 5-12) _____S.U.

VII. Temperature of Neutralized Waste at Time of Discharge: (must be 40°C or lower) _____C°

_____ _____ _____

Operator Plant Manager

PERMIT

AIR QUALITY SERVICE
ENVIRONMENTAL HEALTH SERVICES
OKLAHOMA STATE DEPARTMENT OF HEALTH
OKLAHOMA CITY, OKLAHOMA 73152

Date May 29, 19 86 Permit No. 86-017-0

The Bio-Cide International, having complied with the requirements of the law, is hereby granted permission to operate their facility for the production of stabilized chlorine dioxide solutions at their site in Norman, Oklahoma, in Cleveland County as specified in the permit application information and data,

subject to the following conditions, attached:

- ☒ Standard Conditions
- ☐ Standard Conditions for EPA New Source Performance Standards
- ☐ Specific Conditions

John Drabek — Chief, Air Quality Service

Mark Coleman — Deputy Commissioner for Environmental Health Services

Joan K. Leavitt, M.D. — Commissioner of Health

ODH Form No. 885
Revised 5/82

000545

PERMIT TO OPERATE AIR
POLLUTION CONTROL FACILITY
(continued)

Standard Conditions

1. If any statement or representation in the application is found to be incorrect, this permit may be revoked and the permittee thereupon waives all rights thereunder; however, the application may be amended and a supplemental written permit issued therefor.

2. Any modification of operating procedures from those for which this permit was issued which results in an increase in emission of air contaminants without notification of Air Quality Service, Oklahoma State Department of Health, shall be grounds for revocation of this permit.

3. Any agent of the Oklahoma State Department of Health shall have the right and authority to inspect at reasonable times the operation of the equipment for which this permit is issued.

4. This permit shall not be considered in any manner affecting the title of the premises upon which the equipment is located, does not release the permittee from any liability for damage to persons or property caused by or resulting from the maintenance or operation of the equipment for which this permit is issued, and does not release the permittee from compliance with other applicable rules, regulations and statutes of Oklahoma or with applicable local laws, rules, regulations or ordinances.

5. This permit is subject to periodic review and change as deemed necessary to fulfill the intent and purposes of the Oklahoma Clean Air Act and rules and regulations promulgated in accordance therewith.

6. In compliance with Section 11.1 of Regulation No. 11 (Malfunction of Control Equipment), written notice containing the information required by this section shall be submitted to Air Quality Service of the Oklahoma State Department of Health.

7. In compliance with Section 11.2 of Regulation No. 11, the operator of the equipment for which this permit is issued will notify Air Quality Service, Oklahoma City, Oklahoma, phone (405) 271-5220, and when the emergency has been controlled, submit to Air Quality Service, Oklahoma State Department of Health, the information required in this section within 30 days of the occurrence.

$T_a + C_bT_b + \ldots C_nT_n) \div 8$

uivalent exposure for the work-

oncentration during any period
the concentration remains

ration in hours of the exposure
ntration C.

of *E* shall not exceed the 8-
weighted average limit in
Z-2, or Z-3 for the material

llustrate the formula pre-
paragraph (d)(1)(i) of this
te that isoamyl acetate has
time weighted average limit
m. (table Z-1). Assume that
ee is subject to the follow-
re:

s exposure at 150 p/m
s exposure at 75 p/m
rs exposure at 50 p/m

ng this information in the
ve have

$+2\times75+4\times50) \div 8=81.25$ p/m

25 p.p.m. is less than 100
e 8-hour time weighted aver-
the exposure is acceptable.
n case of a mixture of air con-
s an employer shall compute
alent exposure as follows:

$C_a \div L_a + C_b \div L_b) + \ldots (C_n \div L_n)$

he equivalent exposure for the

centration of a particular con-

exposure limit for that contami-
table Z-1, Z-2, or Z-3.

ue of *Em* shall not exceed

illustrate the formula pre-
n paragraph (d)(2)(i) of this
consider the following expo-

aterial	Actual concentration of 8-hour exposure	8-hour time weighted average exposure limit
ble Z-1)	500 p/m	1,000 p/m
(Table Z-1)	45 p/m	200 p/m
ble Z-2)	40 p/m	200 p/m

ting in the formula, we have:

$Em = 500 \div 1,000 + 45 \div 200 + 40 \div 200$
$Em = 0.500 + 0.225 + 0.200$
$Em = 0.925$

Since *Em* is less than unity (1), the exposure combination is within acceptable limits.

(e) To achieve compliance with paragraph (a) through (d) of this section, administrative or engineering controls must first be determined and implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or any other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and/or technical measures used for this purpose must be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with § 1910.134.

TABLE Z-1

Substance	p/m³	mg./M³
Acetaldehyde	200	360
Acetic acid	10	25
Acetic anhydride	5	20
Acetone	1,000	2,400
Acetonitrile	40	70
Acetylene dichloride, see 1, 2-Dichloroethylene		
Acetylene tetrabromide	1	14
Acrolein	0.1	0.25
Acrylamide—Skin		0.3
Aldrin—Skin		0.25
Allyl alcohol—Skin	2	5
Allyl chloride	1	3
C Allylglycidyl ether (AGE)	10	45
Allyl propyl disulfide	2	12
2-Aminoethanol, see Ethanolamine		
2-Aminopyridine	0.5	2
Ammonia	50	35
Ammonium sulfamate (Ammate)		15
n-Amyl acetate	100	525
sec-Amyl acetate	125	650
Aniline—Skin	5	19
Anisidine (o, p-isomers)—Skin		0.5
Antimony and compounds (as Sb)		0.5
ANTU (alpha naphthyl thiourea)		0.3
Arsenic organic compounds (as As)		0.5
Arsine	0.05	0.2
Azinphos-methyl—Skin		0.2
Barium (soluble compounds)		0.5
p-Benzoquinone, see Quinone		
Benzoyl peroxide		5
Benzyl chloride	1	5
Biphenyl, see Diphenyl		
Boron oxide		15
C Boron trifluoride	1	3
Bromine	0.1	0.7

TABLE Z-1—Continued

Substance	p/m³	mg./M³
Bromoform—Skin	0.5	5
Butadiene (1, 3-butadiene)	1,000	2,200
Butanethiol, see Butyl mercaptan		
2-Butanone	200	590
2-Butoxy ethanol (Butyl Cellosolve)—Skin	50	240
Butyl acetate (n-butyl acetate)	150	710
sec-Butyl acetate	200	950
tert-Butyl acetate	200	950
Butyl alcohol	100	300
sec-Butyl alcohol	150	450
tert-Butyl alcohol	100	300
C Butylamine—Skin	5	15
C tert-Butyl chromate (as CrO_3)—Skin		0.1
n-Butyl glycidyl ether (BGE)	50	270
Butyl mercaptan	10	35
p-tert-Butyltoluene	10	60
Calcium oxide		5
Camphor		2
Carbaryl (Sevin®)		5
Carbon black		3.5
Carbon dioxide	5,000	9,000
Carbon monoxide	50	55
Chlordane—Skin		0.5
Chlorinated camphene—Skin		0.5
Chlorinated diphenyl oxide		0.5
C Chlorine	1	3
Chlorine dioxide	0.1	0.3
C Chlorine trifluoride	0.1	0.4
C Chloroacetaldehyde	1	3
a-Chloroacetophenone (phenacylchloride)	0.05	0.3
Chlorobenzene (monochlorobenzene)	75	350
o-Chlorobenzylidene malononitrile (OCBM)	0.05	0.4
Chlorobromomethane	200	1,050
2-Chloro-1,3-butadiene, see Chloroprene		
Chlorodiphenyl (42 percent Chlorine)—Skin		1
Chlorodiphenyl (54 percent Chlorine)—Skin		0.5
1-Chloro, 2,3-epoxypropane, see Epichlorhydrin		
2-Chloroethanol, see Ethylene chlorohydrin		
Chloroethylene, see Vinyl chloride		
C Chloroform (trichloromethane)	50	240
1-Chloro-1-nitropropane	20	100
Chloropicrin	0.1	0.7
Chloroprene (2-chloro-1,3- butadiene)—Skin	25	90
Chromium, sol. chromic, chromous salts as Cr		0.5
Metal and insol. salts		1
Coal tar pitch volatiles (benzene soluble fraction) anthracene, BaP, phenanthrene, acridine, chrysene, pyrene		0.2
Cobalt, metal fume and dust		0.1
Copper fume		0.1
Dusts and Mists		1
Cotton dust (raw)		1†
Crag® herbicide		15
Cresol (all isomers)—Skin	5	22
Crotonaldehyde	2	6
Cumene—Skin	50	245
Cyanide (as CN)—Skin		5

Joan K. Leavitt, M.D.
Commissioner

OKLAHOMA STATE DEPARTMENT OF HEALTH

P.O. BOX 53551
1000 N.E. TENTH
OKLAHOMA CITY, OK 73152

AN EQUAL OPPORTUNITY EMPLOYER

June 4, 1986

RECEIVED JUN 5 1986

Mr. James P. Ringo
Associate Technical Director
Bio-Cide International, Inc.
P.O. Box 2700
Norman, OK 73070

Re: Operating Permit 86-017-0
Bio-Cide International, Inc.
Norman, Cleveland County, Oklahoma
Facility for the Production of Stabilized Chlorine Dioxide Solutions

Dear Mr. Ringo:

Enclosed is the permit authorizing operation of the referenced facility. Please note that this permit is issued subject to certain standard conditions which are attached.

Thank you for your cooperation in this matter. If we may be of further service, please contact our office.

Very truly yours,

Joyce D. Sheedy
Environmental Engineer
Permits & Enforcement Division
AIR QUALITY SERVICE

JDS/cw
Enclsr.

000548

Title: Safety in the Workplace: Ambient Chlorine Dioxide Measurements in the Presence of Chlorine

Authors: Gilbert Gordon,* Bernard Bubnis, and Gilbert Pacey, Miami University, Oxford, OH

ClO_2 PEL 0.1 ppm
STEL = 0.3 ppm (V/V)
TLV = $\mu L\, ClO_2 / 1 L$ air
= 0.27 mg / m^3

ABSTRACT

A study was undertaken to measure and model ambient chlorine dioxide (ClO_2) concentrations in the presence of chlorine (Cl_2). The permissible exposure level (PEL) for ClO_2 as established by the Occupational Health & Safety Administration (OSHA), is 0.1 ppm (≈0.3 mg/m^3) and the short term exposure limit (STEL) is 0.3 ppm (≈0.9 mg/m^3). Measurements were made using ion mobility spectrometry (IMS) to quantitate ambient ClO_2 concentrations under laboratory "spill" conditions. Rates of emission or volatilization "downwind" at specified heights and distances from the spill were calculated.

Chlorine dioxide at equilibrium and 25 °C, is about 23 times more concentrated in aqueous solution or about 10 times more soluble in water than Cl_2 which it resembles in appearance and odor. The commercial generation of ClO_2 usually involves Cl_2, a fact that causes great confusion and inaccuracies in ambient ClO_2 measurements. The most readily available and commonly used "monitors" are unable to speciate ClO_2 in the presence of Cl_2.

IMS is a time of flight technique. Sample (ambient air or a process stream) is drawn through an inlet and permeates across a membrane (which provides a limited degree of selectivity) to a reaction cell. In the cell, the sample is ionized by a series of ion-molecule reactions under the influence of an electric field. The ions enter a "drift" region and are separated according to size and shape. Components are identified based on a drift time similar to gas chromatography but on the millisecond time scale.

Data will be presented describing the experiments, the model and its usefulness in predicting exposure levels to ambient ClO_2.

INTRODUCTION

Chlorine dioxide (ClO_2) is a selective and versatile oxidant which has been applied at many industrial worksites in the agriculture, food processing, iron and steel, pulp and paper, textiles, water purification and wastewater treatment fields. Chlorine dioxide has an Occupational Health and Safety Administration (OSHA) permissible exposure limit (PEL) of 0.1 ppm (≈0.3 mg/m^3) and a short term exposure limit (STEL) of 0.3 ppm (≈0.9 mg/m^3).

Gilbert Gordon Department of Chemistry, Miami University, Oxford, OH 45056

Acute exposure results in irritation to the eyes, nose, throat and lungs. Prolonged exposure can cause chronic bronchitis, reactive airways disease and pulmonary edema.

A study was undertaken to measure and model ambient ClO_2 concentration in the presence of Cl_2 under conditions similar to an event that occurred at a potato processing plant where chlorine dioxide was used in french fry mixing tanks. Over a four year period, employee exposure complaints were documented at the uncovered mixing tanks believed to contain 0.5 mg/L aqueous chlorine dioxide. Following a large spill incident, the chlorine dioxide system was removed and a lawsuit was brought by employees who had physician documented evidence of pulmonary injury. A series of small scale laboratory experiments were subsequently undertaken to evaluate the likelihood of employee injury from sufficient chlorine dioxide volatilization at the former mixing tanks.

At equilibrium and 25 °C, ClO_2 is about 23 times more concentrated in aqueous solution than in the gas phase or about 10 times more soluble in water than chlorine (Cl_2) which it resembles in appearance and odor. The generation of ClO_2 usually involves Cl_2, a fact that causes great confusion and inaccuracies in gas phase ClO_2 measurements since most monitors are unable to speciate ClO_2 in the presence of Cl_2. The laboratory measurement of ClO_2 in the presence of Cl_2 was made using ion mobility spectroscopy (IMS). Rates of emission or volatilization "downwind" at specified heights and distances from the "spill" were measured and volatilization half-lives were calculated using the two-film concept. An estimated volatilization half-life of 4.3 hours at the 2,000 liter mixing tanks was calculated corresponding to a chlorine dioxide emission rate of 2.5×10^{-5} g/sec (60 sec = 1.5 mg).

VOLATILIZATION MODELLING

Volatilization is affected by many factors[1] including the Henry's Law constant and the physical properties of aqueous solubility, vapor pressure, diffusivity coefficient and rate-controlling factors such as water body depth, presence of turbulence, sediment content and wind speed and stability. The calculation of rates of emission and volatilization half-life require the application of Henry's Law which states[2] that "the mass of a slightly soluble gas that dissolves in a definite mass of a liquid at a given temperature is very nearly directly proportional to the partial pressure of that gas".

The general procedure for calculating rates of volatilization[1] are as follows:

1. Calculate the Henry's Law Constant (H). If $H>3\times10^{-7}$, the chemical can be considered volatile.

2. Determine the nondimensional Henry's Law Constant (H').

$$H' = H/RT$$

3. Compute the liquid-phase exchange coefficient (k_l).

$$k_l = 23.51(V_c^{0.969}/Z_{0.673})(32/M)^{½} \text{ cm/hr}$$

where: V_c = liquid flow velocity
Z = liquid depth
M = molecular weight

4. Compute the gas-phase exchange coefficient (k_g).

$$k_g = 1137.5(V_w + V_c)(18/M)^{½} \text{ cm/hr}$$

where: Vw = wind velocity above liquid
V_c = liquid flow velocity
M = molecular weight

5. Compute the overall liquid-phase mass transfer coefficient (k_L).

$$k_L = \frac{(H/RT)k_g k_l}{(H/RT)k_g + k_l} \text{ cm/hr}$$

6. Compute the volatilization half-life ($\tau_{½}$)

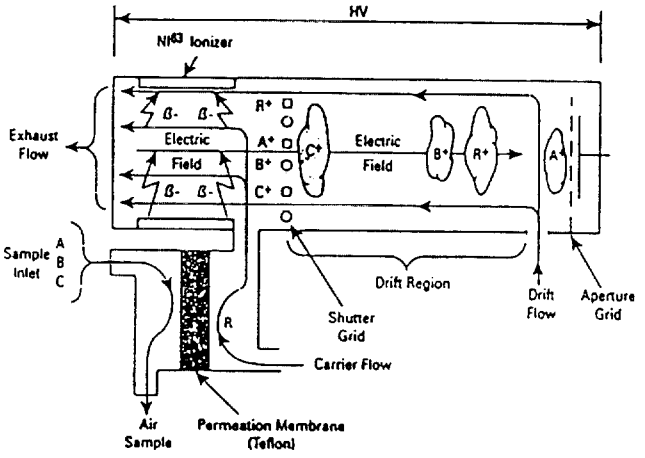
$$\tau_{½} = 0.69\ Z/k_L = 0.69/k_V$$

where $k_V = k_L/Z$ = volatilization rate constant

CHLORINE DIOXIDE DETECTION

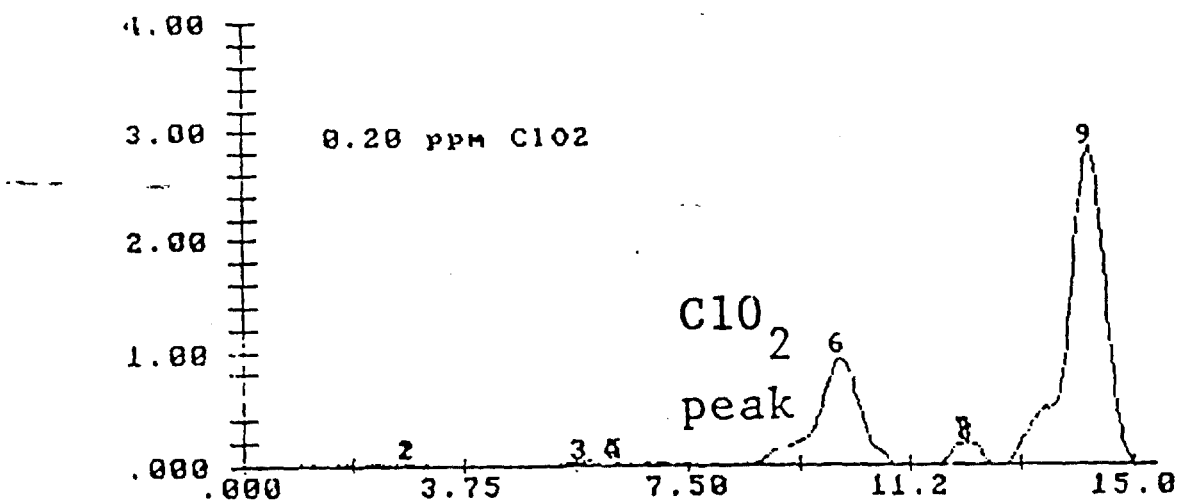
Chlorine dioxide in the gas phase was measured using ion mobility spectroscopy. Figure 1 is a schematic of an IMS sample chamber[3]. Sample (ambient air or a process stream gas) is drawn into an inlet and the compounds of interest permeate across a membrane which provides a limited degree of selectivity.

Figure 1. IMS Cell Schematic



On the receiving side of the membrane, compounds are swept up by a carrier gas that delivers the sample to a reaction cell. In the cell, the sample is ionized by a series of ion-molecule reactions initiated by β particles emanating from a Ni^{63} source. These ions are attracted under the influence of an electric field to a shutter. The shutter opens and closes periodically to allow the ions into a "drift region" where they separate according to the size and shape of the specific ion and arrive at a collector grid at a unique "drift time". Components are identified based on a drift time (Figure 2) similar to gas chromatography but on the millisecond time scale[4]. Fixed point IMS is achieved by monitoring the unique drift time of the component of interest.

Figure 2. IMS "Drift" Spectrum of Chlorine Dioxide[5]



All IMS measurements were made using a Sensidyne/ETG fixed point ion mobility spectrometer calibrated with a Sensidyne ToxiCal chlorine dioxide gas generator. Real-time strip chart recordings were gathered using a Servogor 111 recorder interfaced to the spectrometer through a 4-20 mA current loop.

Chlorine dioxide solutions of concentrations up to 5000 mg/L were prepared[6,7] by mixing potassium persulfate with sodium chlorite in a two tower bubble chamber using nitrogen as a carrier gas. The solution concentrations were verified by UV measurement at 360 nm using short pathlength quartz cells and a Milton-Roy 3300 Diode Array Spectrophotometer.

Spill experiments were carried out in either a small pan (10 liter) or a 50 gallon stainless steel tank placed in an empty room measuring approximately 40' × 60' × 10'. Air flow above the tank was provided by a two-step circuiating fan. Turbulent surface mixing was achieved using a variable speed paint mixer. Measurements taken at various heights above the spill tank were made by adjusting the IMS instrument to the desired height from a ceiling pulley.

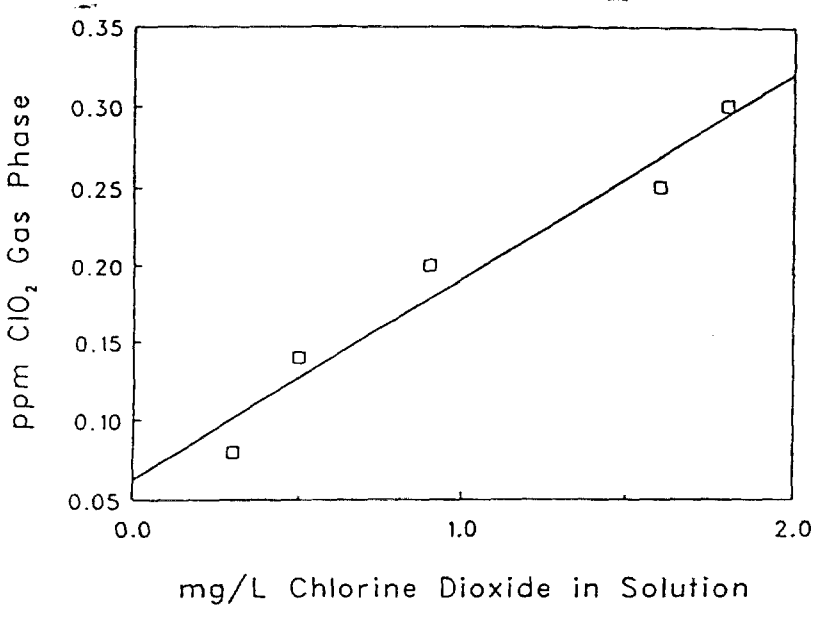
LABORATORY "SPILL" EXPERIMENTS

A series of experiments was undertaken to measure the ambient chlorine dioxide concentration as a function of solution chlorine dioxide concentration, distance and height from the mixing tank, and surface turbulence. These data were used to calculate a measured chlorine dioxide volatilization half-life and rate constant which were then compared to predicted values.

Gas phase measurements described in terms of "parts per million" can be confusing. Generally the gas phase concentration is a volume-volume (v/v) relationship meaning that a 5 ppm (v/v) chlorine dioxide concentration is equivalent to 5×10^{-6} liters of chlorine dioxide in 1 liter of air or 0.276 mg of chlorine dioxide in m^3 of air.

Figure 3 shows ambient chlorine dioxide measurements taken 1 meter above the small 10 liter holding pan containing dilute chlorine dioxide solutions (<2 mg/L). Under highly concentrated conditions (200 - 860 mg/L), a similar linear effect was exhibited in the large tank experiments with measurement at 2 meters above the tank.

Figure 3. Chlorine Dioxide Diffusion Into The Gas Phase At Low Concentration



Experiments were undertaken to determine the effect of distance from the mixing tank in the presence and absence of air motion above the tank. At increasing distances from the mixing tank, ambient measurements decreased. This was not unexpected considering the reactivity of chlorine dioxide and the potential for gas phase dilution to occur when measuring at points further away from the mixing tank. Upon the application of moving air above the mixing tank, ambient chlorine dioxide measurements also increased. Under "splash" conditions with moving air, two fronts of chlorine dioxide vapor were measured. The first vapor wave appeared to be higher in concentration and is postulated to be the product of a large initial release of chlorine dioxide at the time of the spill. The second more controlled vapor wave appeared to be under pseudo equilibrium conditions showing a gradual decrease

in ambient chlorine dioxide as the surface area of the tank settled. This same effect was also noticed in experiments where surface turbulence was added. Figure 5 shows a release profile of chlorine dioxide in an open tank with surface mixing.

Figure 4. Chlorine Dioxide Diffusion Into The Gas Phase At High Concentration

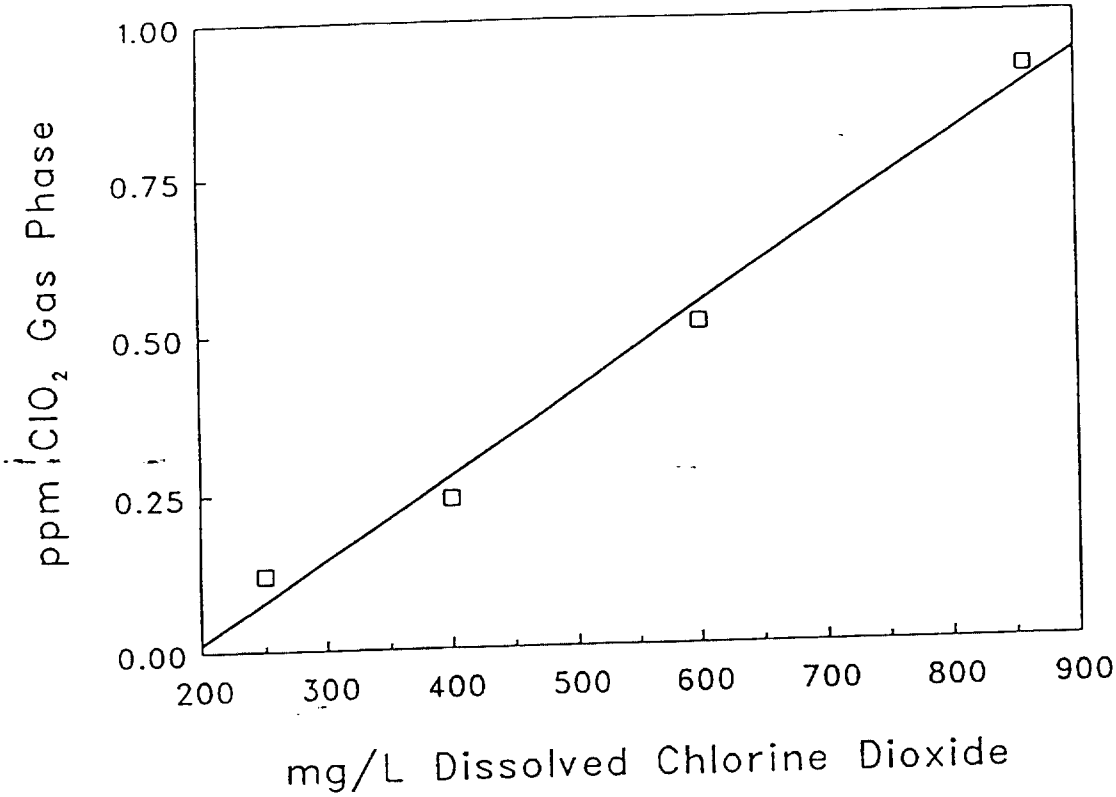
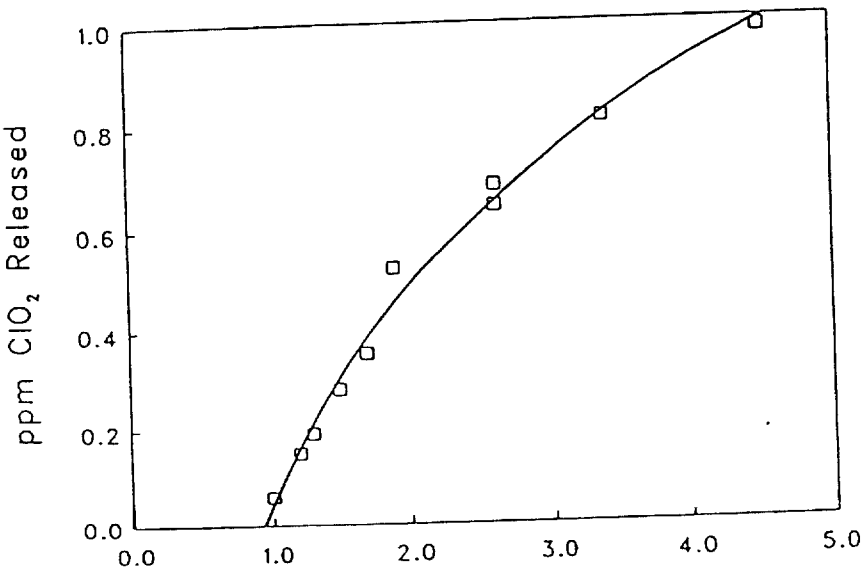


Figure 5. Impact of Surface Mixing on Chlorine Dioxide Release



CALCULATED VOLATILIZATION PARAMETERS

The following parameters were calculated for chlorine dioxide.

Henry's Law Constant, H	4.0×10^{-2} atm m^3/mole
Nondimensional Henry's Law Constant, H'	1.7
Liquid-phase exchange coefficient, k_l	16.1 cm/hr
Gas-phase exchange coefficient, k_g	1549.2 cm/hr
Overall liquid-phase mass transfer coefficient, k_L	16.0 cm/hr
Rate constant, k_V	0.01 min^{-1}
Volatilization half-life, $\tau_{1/2}$	66 min

The chlorine dioxide volatilization rate constant is calculated as the slope of chlorine dioxide concentration *vs.* time as shown in Figure 6. The measured slope (0.024 ± 0.002)) *vs.* predicted (0.01) differed by only a factor of two at the 95% confidence level (predictive techniques are generally in agreement with actual processes within a factor of 10 and probably a factor of 2 or 3 in most cases). The corresponding measured half-life ($\tau_{1/2}$) was calculated to be between 25 -35 minutes.

Adjusting the calculations for the larger 2,000 liter mixing tanks at the potato plant, a $\tau_{1/2}$ of 4.3 hours was estimated giving a chlorine dioxide emission rate of 2.5×10^{-5} g/sec. This rate of emission coupled with dispersion modelling demonstrated the likelihood that ambient chlorine dioxide concentrations above the OSHA PEL and subsequent employee exposure at plant locations within 20 feet of the mixing tanks as shown in Figure 7.

Figure 6. Chlorine Dioxide Rate Constant Curves

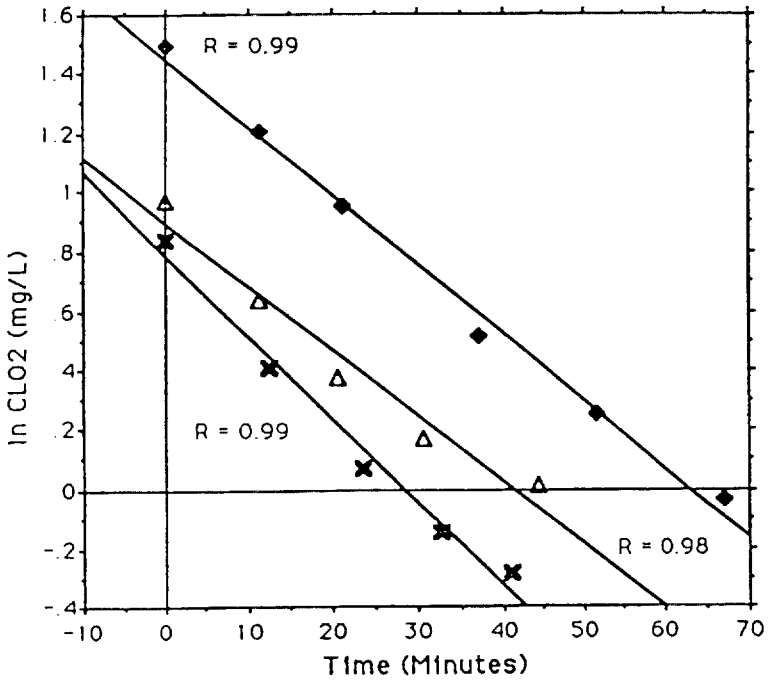
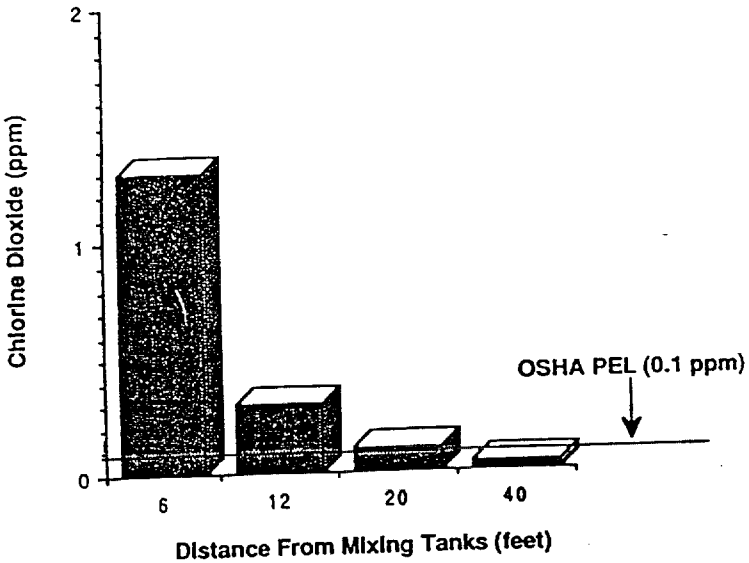


Figure 7. Ambient Chlorine Dioxide Predictive Model



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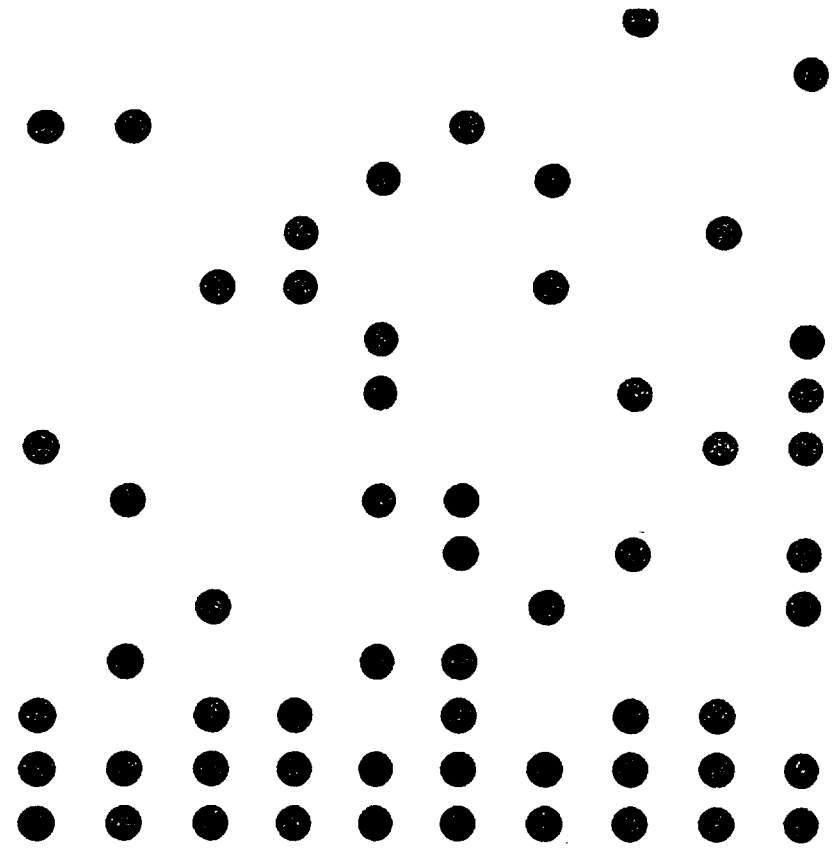

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 21 1992

OFFICE OF
PESTICIDES AND TOXIC
SUBSTANCES

Mr. James P. Ringo
Technical Director
Bio-Cide International, Inc.
P.O. Box 722170
Norman, OK 73070-8644

Dear Mr. Ringo:

In your letter of October 6, 1990, you asked if sodium chlorite data is acceptable to fulfill chlorine dioxide guideline requirements. The Agency has reviewed your request and has agreed to accept sodium chlorite data to support your chlorine dioxide requirements for ecological effects, environmental fate, toxicology, and residue guidelines.

You may want to request waivers of ecological effects data based on the similarity of the environmental chemistry of chlorine dioxide to other oxychlorine compounds.

If you have any questions regarding this letter, please call Betty Crompton in the Accelerated Reregistration Branch at (703) 308-8067.

Sincerely Yours,

Barbara L. Briscoe, Section Head
Accelerated Reregistration Branch
Special Review and
Reregistration Division

cc: Walter Francis, RD PM

Oklahoma's Endangered Species

Whooping Crane

Department of Wildlife Conservation
1801 N. Lincoln Blvd.
Oklahoma City, OK 73105

Oklahoma's Endangered Species

Through exploitation and habitat destruction, man has increased the rate of wildlife extinction to an alarming level. Scientists estimate that one to three species become extinct per day worldwide. If this rate continues, 15 to 20 percent of all species on earth could be extinguished by year 2000.

Rigorous conservation measures are needed to combat wildlife extinction. The Endangered Species Act is one important step that has already been taken. This federal law, passed in 1973, mandates officially listing endangered and threatened species, devising recovery plans and protecting habitat as well as providing financial assistance for state research and recovery programs, and restricting illegal trade of listed species.

Adding a species to the federal endangered species list is an extremely complex process that involves the public, state and federal government and private organizations. Since the federal act was passed, more than 639 animals and plants have been listed as endangered or threatened within the United States and many more are being considered (see page 11).

In 1985, the state Legislature empowered the Oklahoma Wildlife Commission to identify Oklahoma's endangered and threatened species that are not on the federal list. Since then, the Commission has included three species on the state list. Species listed as federally threatened or endangered are automatically included on the state's list in the same category.

Once a species has been classified as endangered, it receives special protection. It is illegal to hunt, collect, kill, injure, harass, or otherwise take endangered wildlife, as well as to purchase or sell an endangered species in interstate or foreign commerce. Criminal violations against federally listed species are punishable by up to $50,000 in fines and one year in jail. Civil violations receive a maximum penalty of $25,000. Violations against state listed species are punishable by up to $1,000 in fines and/or imprisonment in county jail for up to 30 days.

Despite these efforts, endangered wildlife species still die out. Habitat loss, pesticide poisoning, certain forestry practices and illegal shooting could spell the end for some species.

A bar chart on page 12 illustrates the factors that contribute to the disappearance of wildlife species. This graph also shows that regulated hunting is not responsible for the decline of any wildlife species. In fact, revenue from sport hunting is used to protect game and nongame animals by providing the means to buy and manage habitat.

As of 1992, 17 Oklahoma wildlife species, seven mammals, eight birds, one mussel and one insect have been officially listed by the federal government as endangered. Two birds, three fish and one reptile species have been classified as threatened. Additionally, one freshwater mussel, one cave crayfish and one longnose darter species have been listed as state endangered, and two fish as state threatened. All of these animals once inhabited Oklahoma, though some were never present in large numbers. Some have been extirpated from the state, although they continue to exist elsewhere, and a few have become extinct (see page 12).

As defined by the Endangered Species Act of 1973, species become classified as endangered because they are in danger of extinction throughout all or a significant portion of their range. A "threatened" classification means that it is likely for a species to become endangered within the foreseeable future.

Endangered and Threatened Species of Oklahoma

Contents

Date Prepared: April 1993

Preface

When the Endangered Species Act was passed in 1973, the course was set for a new direction in wildlife conservation. The act, which stated that endangered and threatened species of animals and plants... "are of esthetic, ecological, educational, historical, recreational, and scientific value to the Nation and its people," was the most far-reaching law ever enacted by any nation for the preservation of endangered species. The act created an international program involving the support of both the public and private sectors. It provides a framework for the federal government, the states, conservation organizations, individual citizens, businesses and industries, and foreign governments to work together to conserve endangered wildlife and plants throughout the world. Under the act, the Secretary of the Interior, acting through the U.S. Fish and Wildlife Service (USFWS), oversees the protection and conservation of all forms of animals and plants found to be in serious jeopardy.

Only species that are federally listed as endangered or threatened have been included in this publication. The information provided is general in nature. Specific information on species distribution, habitat, the Section 7 consultation process, availability of recovery plans, and other aspects of the endangered species program can be obtained from:

U.S. Fish and Wildlife Service
Oklahoma Ecological Services Field Office
222 S. Houston, Suite A
Tulsa, Oklahoma 74127
Phone: 918-581-7458

The Oklahoma Department of Wildlife Conservation maintains a list of species that are considered endangered within the state and are protected by state law. Information regarding these state listed species may be obtained from:

Oklahoma Department of Wildlife Conservation
1801 N. Lincoln, P.O. Box 53465
Oklahoma City, Oklahoma 7315
Phone: 405-521-3851

This publication is a cooperative effort between the U.S. Fish and Wildlife Service; the Oklahoma Cooperative Extension Service, Oklahoma State University; the Oklahoma Department of Agriculture Plant Industries Division; the U.S. Environmental Protection Agency; the Oklahoma Department of Wildlife Conservation; and the Oklahoma Natural Heritage Inventory Program.

Partial funding of this publication was provided by the Oklahoma Department of Agriculture.

Introduction

As of August 4, 1992, 728 species had been added to the national list of endangered and threatened species. Twenty of these species have been recorded in Oklahoma, although the Eskimo curlew has not been observed in the state since 1948 and the eastern prairie-fringed orchid has not been found since 1918.

Why Save Endangered Species?

Saving species is important to many people for a variety of reasons. People care about saving species for their beauty and the thrill of seeing them; for scientific and educational purposes; and for their ecological, historic, and cultural values. Each species plays an important role in the environment. When a species becomes endangered, it indicates that something is wrong with the environment on which we all depend. The measures we take to save endangered species will help ensure that the planet we leave for our children is as healthy as the planet our parents left for us.

Causes of Decline

We can no longer blame the rapid loss of our wild animals and plants on "natural" causes. Habitat destruction is the single most serious threat to wildlife and plants. Other causes that can contribute to a species' decline include exploitation for commercial or other purposes, disease, predation, inadequate conservation laws, pollution, introduction of non-native species, or a combination of these factors.

U.S. Fish and Wildlife Service

The primary objective of the U.S. Fish and Wildlife Service endangered species program is protecting endangered and threatened species and restoring them to a secure status in the wild. The USFWS' endangered species responsibilities include:

- Listing, reclassifying, and delisting species under the Endangered Species Act;
- Reviewing federal actions to ensure that they do not jeopardize the continued existence of listed species;
- Enforcing species protection under the act;
- Overseeing recovery activities for listed species;
- Providing for the protection of important habitat; and
- Providing grants to states to assist with their endangered species conservation efforts.

What You Can Do To Help

- Find out which species in your area are endangered or threatened. Ask the U.S. Fish and Wildlife Service or the Oklahoma Department of Wildlife Conservation how you can help protect these species.
- Be informed about other wildlife and conservation issues in your area and tell others what you have learned.
- Visit one of the national wildlife refuges or the state wildlife management areas in Oklahoma. Become a volunteer or help out on special projects at a refuge or wildlife management area near your home.
- Join a conservation group.
- Report violations of wildlife laws to your local game ranger.
- Don't buy exotic or wild animals as pets. They are expensive and difficult to keep, and could be protected by law.
- Don't buy products made from endangered or threatened wildlife.
- Before traveling overseas, write to the U.S. Fish and Wildlife Service, Publications Unit, 130 Arlington Square, Washington, D.C. 20240, for a copy of the brochures "Facts about Federal Wildlife Laws" and "Buyer Beware," which explain what cannot be imported.
- Set an example by recycling and being careful not to litter. Balloons, discarded fishing line, and plastic six-pack rings can suffocate, entrap, or strangle wildlife. Participate in clean-up projects, or start your own project.
- Plan a vacation around observing wildlife in its natural habitat. Look for state, federal, or private wildlife conservation areas near your destination.
- Check your local library for reference books and directories, such as the "Conservation Directory" published by the National Wildlife Federation, for additional information.

Species Account

Western Prairie Fringed Orchid (*Platanthera praeclara*)

STATUS: Threatened (54 FR 39857; September 28, 1989). Critical habitat has not been designated.

DESCRIPTION: The western prairie fringed orchid arises from a fleshy tuber. It grows from 1.25 to 3 feet (38-85 cm) tall. Each plant can have up to two dozen or more flowers arranged in a stalk. The flowers are white to creamy in color and more than an inch long. The leaves are long and thin and grow shorter closer to the flower stalk. The western prairie fringed orchid is distinguished from the eastern prairie fringed orchid by its slightly larger flowers, petal shape, and longer nectar spur.

LIFE HISTORY: The western prairie fringed orchid is a long-lived perennial. It emerges in May and blooms in June or in July further north. The flowers are fragrant at night and are pollinated by large sphinx moths.

HABITAT: The western prairie fringed orchid is a plant of the tallgrass prairie and requires direct sunlight for growth. It is most often found in moist habitats or sedge meadows. Western prairie fringed orchids have persisted in areas that have been lightly grazed, periodically burned, or regularly mowed. It is not yet understood how these activities affect plant survival. It may be that removal of dead grass mulch is beneficial, but heavy grazing is detrimental.

DISTRIBUTION: Historically, the western prairie fringed orchid was found in tallgrass prairies west of the Mississippi River. It occurred from extreme southern Canada south to northeastern Oklahoma. In Oklahoma, historical records (1975) exist for Craig and Rogers counties. Currently, extant populations of the orchid are found in Iowa, Kansas, Minnesota, Missouri, Nebraska, and North Dakota.

CAUSES OF DECLINE: The major factor contributing to the decline of the western prairie fringed orchid has been the conversion of native prairie to croplands. Fire suppression, overgrazing, and habitat fragmentation also have contributed to the decline of the species.

Paul Currier

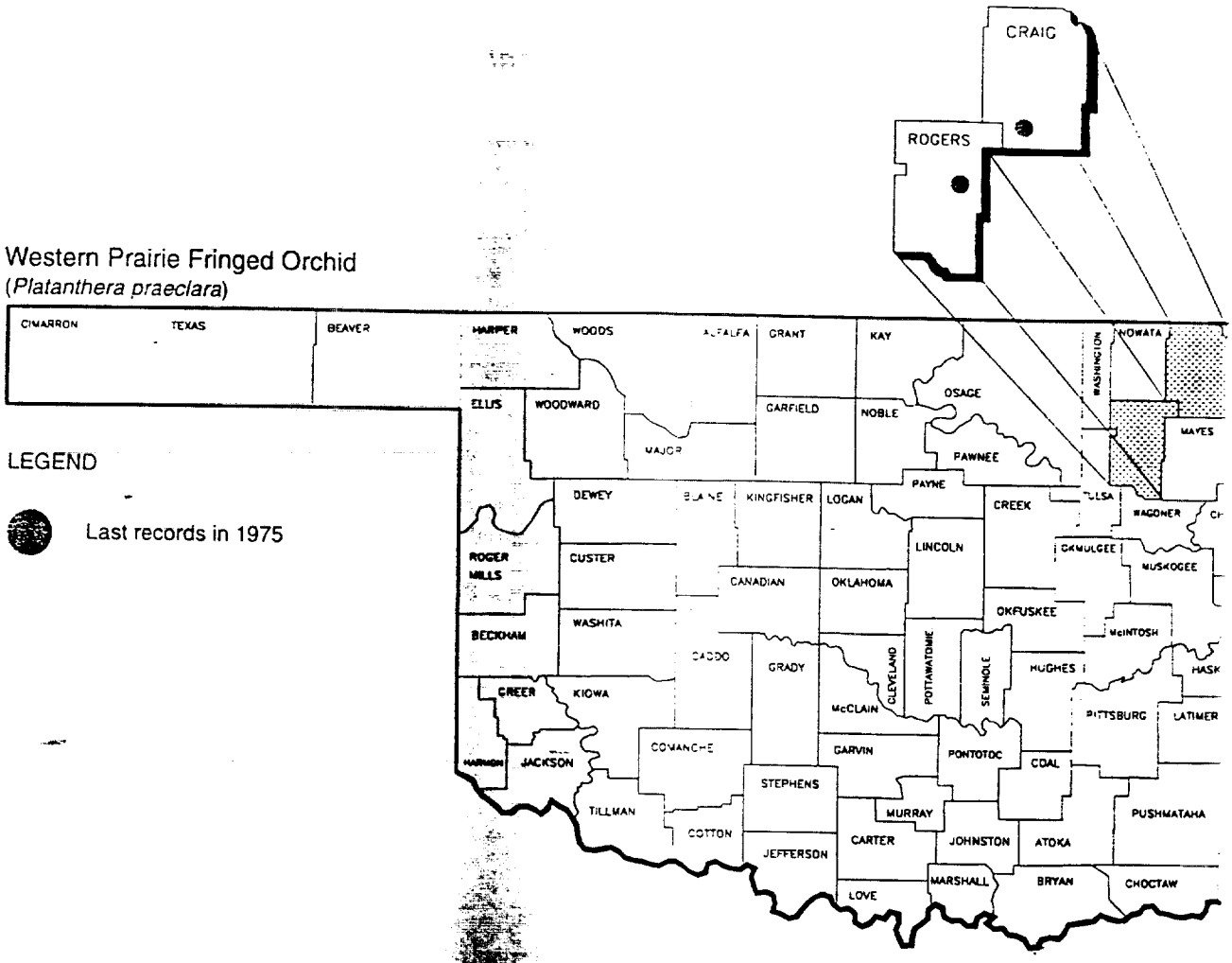
Western Prairie Fringed Orchid (*Platanthera praeclara*)

RECOVERY NEEDS: Research is being done to determine the effects of grazing, burning, and mowing on populations of the western prairie fringed orchid. Finding new populations and protecting known populations are other high priority tasks.

OTHER INFORMATION: The western prairie fringed orchid was described as a distinct species, separate from the eastern prairie fringed orchid in 1986. Both are threatened species.

Date prepared: March 1992

Western Prairie Fringed Orchid
(*Platanthera praeclara*)



LEGEND

● Last records in 1975

000566

Species Account

Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)

STATUS: Threatened (54 FR 39857; September 28, 1989). Critical habitat has not been designated.

DESCRIPTION: The eastern prairie fringed orchid arises from a fleshy tuber. The plant can grow up to three feet tall. The inflorescence is large and showy and may have up to 40 white flowers. The leaves are long and thin. It is distinguished from the western prairie fringed orchid by its smaller flowers [less than one inch (2.5 cm) long], more oval petals, and a shorter nectar spur.

LIFE HISTORY: The eastern prairie fringed orchid is a long-lived perennial plant. Its tuber rootstalk helps it survive grass fires. Fires and rain stimulate the plant to grow and flower. The plant emerges each year in May and flowering begins by late June. The flowers are pollinated at night by large sphinx moths.

HABITAT: The eastern prairie fringed orchid is found in moist to wet tallgrass prairie. In the eastern part of its range, it ~~is found~~ in wet sedge meadows.

DISTRIBUTION: Historically, the eastern prairie fringed orchid occurred east of the Mississippi River and in Iowa and Missouri. Scattered populations are found in Illinois, Indiana, Iowa, Maine, Michigan, New York, Ohio, Virginia, Wisconsin, and Ontario, Canada. A historic record exists for Choctaw County, Oklahoma. The plant has not been observed in Oklahoma within the past 150 years.

CAUSES OF DECLINE: The major factor in the decline of the eastern prairie fringed orchid has been a loss of habitat due to grazing, fire suppression, and agricultural conversion.

Marlin Bowles

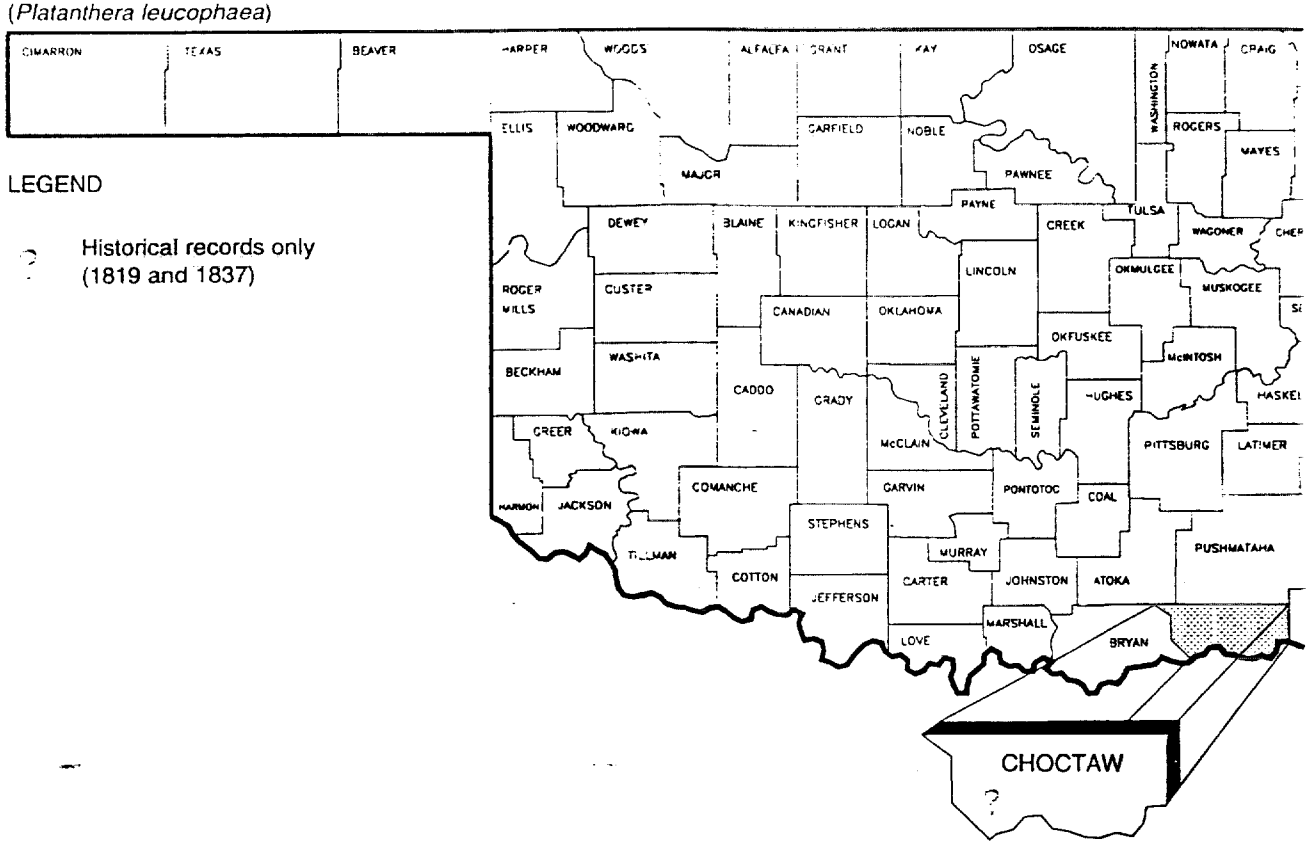
Eastern Prairie Fringed Orchid (*Platanthera leucophaea*)

RECOVERY NEEDS: Populations of the eastern prairie fringed orchid are being monitored and new populations are being sought. It is important to maintain proper habitat for existing populations. This includes periodic burning to eliminate woody vegetation.

OTHER INFORMATION: The first collection (1819) of this species was Arkansas Territory, now Choctaw County. However, it has not been observed in Oklahoma since that time.

Date prepared: March 1992

Eastern Prairie Fringed Orchid
(*Platanthera leucophaea*)



LEGEND

? Historical records only
(1819 and 1837)

000568

Species Account

Ouachita Rock-pocketbook (*Arkansia wheeleri*)

STATUS: Endangered (56 FR 54950: October 23, 1991). Critical habitat has not been designated.

DESCRIPTION: The Ouachita rock-pocketbook is a freshwater mussel. Its shell reaches a maximum size of 4.5 inches (12 cm) long, three inches (8 cm) high, and two inches (5 cm) wide. The shell is relatively thick, moderately inflated, and subovate. The outer surface is chestnut-brown to black with a silky luster. It is distinguished from other similar appearing species by distinctive details of its shell.

LIFE HISTORY: Very little is known about the life history of the Ouachita rock-pocketbook. However, closely related species develop eggs each fall and then release larvae during the spring. The larvae attach to the fins, gills, or scales of fish until they mature. Adults feed by filtering out small particles from the water.

HABITAT: The Ouachita rock-pocketbook is found primarily in pools of small, slow-moving rivers. To a lesser extent, these mussels are present in stream-side channels and backwaters as well. They appear to prefer areas with cobble-gravel bottoms, although they are also found in sandy areas.

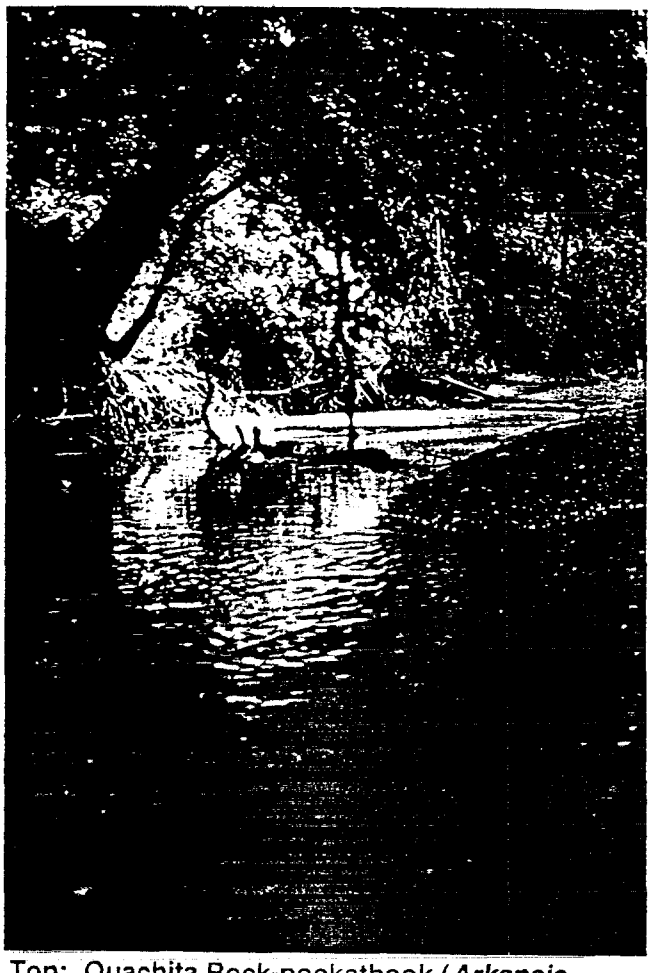
DISTRIBUTION: The historical distribution of the Ouachita rock-pocketbook included the Kiamichi River in southeastern Oklahoma, the Little River in southwestern Arkansas, and the Ouachita River in central Arkansas. Currently, it is limited to a five-mile (8 km) segment of the Little River in Arkansas and an 80-mile (130 km) stretch of the Kiamichi River upstream from Hugo Reservoir.

CAUSES OF DECLINE: The range of the Ouachita rock-pocketbook has been reduced due to the construction of dams and a decrease in water quality. Gravel dredging operations also pose a threat to the species.

RECOVERY NEEDS: The life history and habitat requirements of the Ouachita rock-pocketbook are not well understood and gathering information about these factors is a top priority. Continued surveying for additional populations, monitoring known populations, and protecting their habitat also are needed.

OTHER INFORMATION: The Kiamichi River has an unusually large number of mussel species. However, no more than 1,000 individuals of the Ouachita rock-pocketbook survive in the river and fewer than 100 individuals survive in the Little River.

Pat Mehlhop-Cifelli

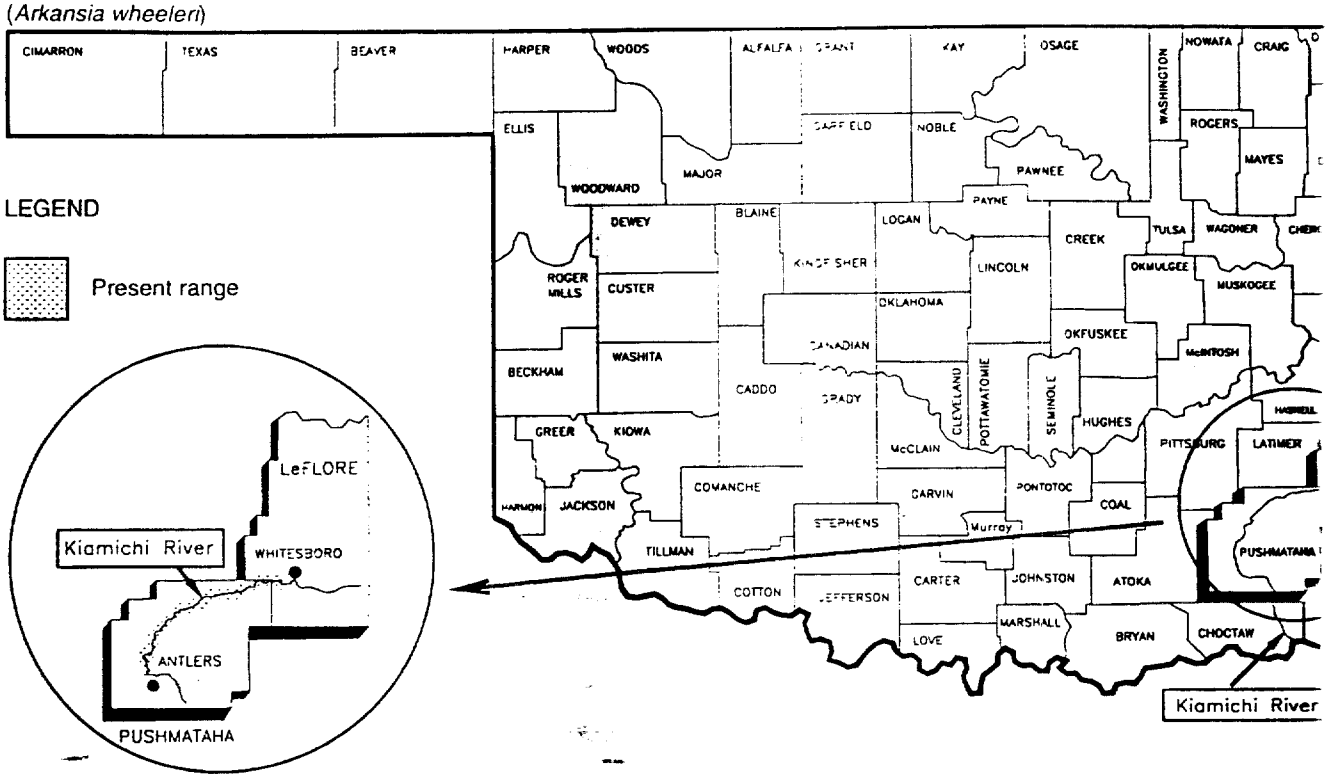


USFWS

Top: Ouachita Rock-pocketbook (*Arkansia wheeleri*). Below: Ouachita Rock-pocketbook habitat.

Date prepared: April 1992

Ouachita Rock-pocketbook
(*Arkansia wheeleri*)



Species Account

American Burying Beetle (*Nicrophorus americanus*)

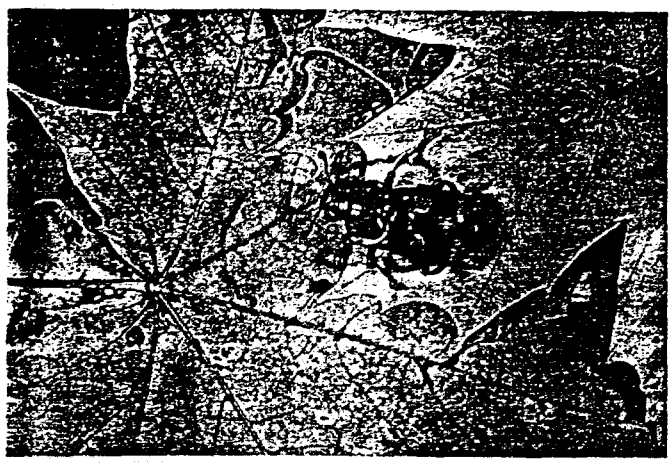
STATUS: Endangered (54 FR 29652; July 13, 1989). Critical habitat has not been designated.

DESCRIPTION: The American burying beetle is a large (1.5 inch; 4 cm) beetle with a shiny black appearance. Wing covers have four, relatively large, orange spots, and the pronotum is red. The beetle feeds on carrion. It was formerly known as the giant carrion beetle.

LIFE HISTORY: The American burying beetle reproduces by burying a small vertebrate carcass (1-9 ounces; 35-250 grams). An underground chamber is formed around the buried carcass, and eggs are laid in a side tunnel exiting the chamber. The larva then feed on the carcass. A positive relationship exists between brood size and carcass size. In the field, brood size has been found to range from three to 31. The American burying beetle is unusual among insects in that both parents provide care to their young. Care involves guarding as well as feeding the young. Adults sometimes have more than one brood in a season. American burying beetles are active on warm (above 60°F or 15°C) nights. Individuals are known to live only about a year.

HABITAT: In Oklahoma, American burying beetles found in the Ouachita Mountains occur in oak-pine woodlands, open fields, and in the transition zone between the two. The other known Oklahoma population occurs on the western edge of the Ozark uplift. These beetles are found in oak-hickory forests and open grasslands. Habitat requirements for the American burying beetle are not fully understood at this time.

DISTRIBUTION: The historical distribution of the American burying beetle includes the eastern half of North America from southern Ontario, Canada, and the northern peninsula of Michigan to the southern Atlantic coastal plain. The western most known occurrence is a 1988 record from Dawes County, Nebraska. The current distribution includes Block Island, Rhode Island, as well as Bryan, Cherokee, Haskell, Latimer, LeFlore, Muskogee, Sequoyah, and Tulsa counties in Oklahoma. About 100 American burying beetles have been reintroduced to Penikese Island, Massachusetts. Their status is currently being monitored.



Andrea J. Kozol

American Burying Beetle (*Nicrophorus americanus*)

CAUSES OF DECLINE: The cause for the decline of this species is undetermined. It may be a result of habitat fragmentation, habitat loss, carcass limitation, pesticides, disease, light pollution, or a combination of these factors.

RECOVERY NEEDS: The highest priority recovery tasks include: 1) protecting and monitoring extant population, 2) maintaining captive populations, 3) continuing the Penikese Island reintroduction attempt, 4) conducting ecological studies, and 5) conducting field surveys for additional populations. The recovery plan was signed on September 27, 1991.

OTHER INFORMATION: Ongoing projects in Oklahoma include a study of the habitat preferences of the American burying beetle and surveys to locate additional populations. Other work includes a genetic comparison of the Oklahoma population with the Block Island population. The population size on Block Island is being estimated annually. Beetles originating from Block Island were used to establish captive populations at Boston University and the Cincinnati Zoo. A third captive population using beetles from Oklahoma is planned.

Date prepared: August 1992

American Burying Beetle
(Nicrophorus americanus)

LEGEND

Known range (March 1993)

Species Account

Leopard Darter (*Percina pantherina*)

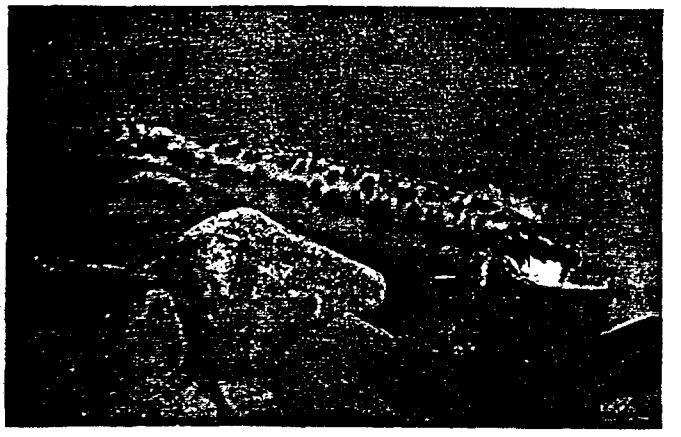
STATUS: Threatened (43 FR 3715; January 27, 1978). Critical habitat has been designated.

DESCRIPTION: Leopard darters rarely exceed three inches (8 cm) in length. They have 10 or more large, dark spots on their back and sides. These spots contrast against a light background that ranges from pale olive on the back to yellowish-olive on the underside.

LIFE HISTORY: Leopard darters typically live less than two years, but individuals older than three years have been found. Spawning occurs in March and April on gravel-bottomed riffles. The fertilized eggs are buried in sand. The average clutch size is about 65 eggs. Young leopard darters begin to appear in May of each year. Food items include aquatic insects and green algae.

HABITAT: Leopard darters are found in intermediate to larger streams within the Little River system. Typically, they are ~~not~~ found in smaller, headwater streams. From May to February, leopard darters prefer large, quiet pools with a rubble and boulder substrate. Spawning occurs during March and April on gravel substrates. However, the dominant riffle substrate may be gravel, rubble, boulder, and bedrock.

DISTRIBUTION: Historically, the leopard darter was limited to upland, large stream habitats of the Little River drainage in Oklahoma and Arkansas. Currently, scattered populations are found within its historic range. In Oklahoma, it occurs within the Little River drainage (Mountain Fork, Glover, and Little rivers) in LeFlore, McCurtain, and Pushmataha counties.



Richard Standage, USFS

Leopard Darter (*Percina pantherina*)

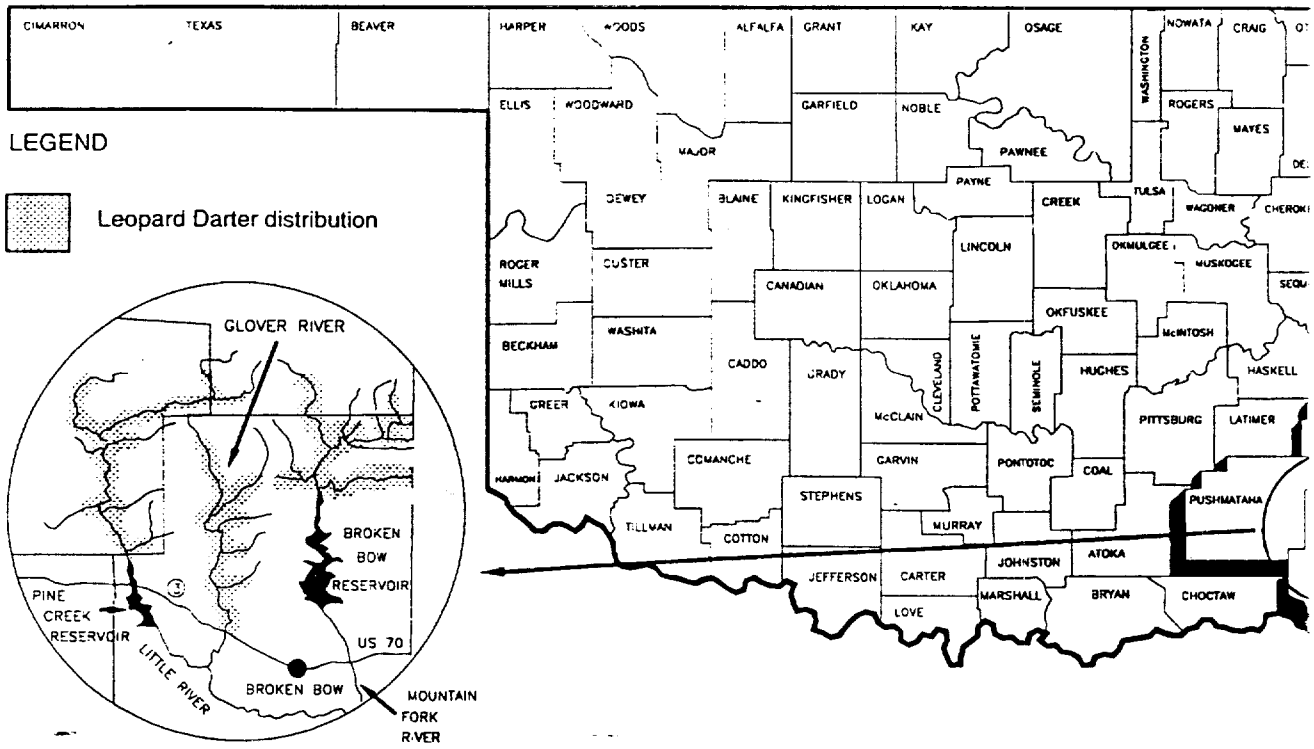
CAUSES OF DECLINE: Leopard darters have never been common. The greatest threat to the survival of the species is the loss of habitat due to the construction of dams. Dams also isolate populations, which further endangers the species. Logging activity, agricultural and industrial run-off, and gravel removal all pose threats as well.

RECOVERY NEEDS: Top recovery tasks for the leopard darter include identification of habitat, research into its general ecology, and managing and protecting its habitat and individual populations.

OTHER INFORMATION: The recovery plan for the leopard darter was completed in 1984, and a revised draft is currently under preparation.

Date prepared: April 1992

Leopard Darter
(*Percina pantherina*)



Species Account

Neosho Madtom (*Noturus placidus*)

STATUS: Threatened (55 FR 21148; May 22, 1990) without critical habitat.

DESCRIPTION: The Neosho madtom has features characteristic of all North American catfish, including scaleless skin and a relatively large head with sensory barbels. Adult Neosho madtoms average less than three inches (8 cm) in length. They have a brownish midline stripe and an overall mottled appearance. The light-colored edge of the adipose fin is the best characteristic to distinguish it from similar species.

LIFE HISTORY: Neosho madtoms are short-lived fish, only occasionally surviving more than three years. Little is known about the reproductive habits of the Neosho madtom. They are believed to spawn in June and July. In closely related species, eggs are laid under small stones, and the eggs and sometimes young fish are guarded by a parent. Adults will bury themselves in the gravel during the day and come out to feed at night. Larval aquatic insects are the major food source of Neosho madtoms.

HABITAT: The preferred habitat of adult Neosho madtoms is shallow riffles with loose gravel bottoms. They are occasionally found in areas with sandy bottoms covered with leaf litter. Young Neosho madtoms are found in deeper pools, downstream from riffles.

DISTRIBUTION: Historically, the Neosho madtom was found in the Neosho, Cottonwood, Spring, and Illinois rivers in Kansas, Missouri, and Oklahoma. It is believed to be no longer present in the Illinois River and scattered through the rest of its historic range. In Oklahoma, it is present only in Ottawa and Craig counties.

Suzanne L. and Joseph T. Collins

Neosho Madtom (*Noturus placidus*)

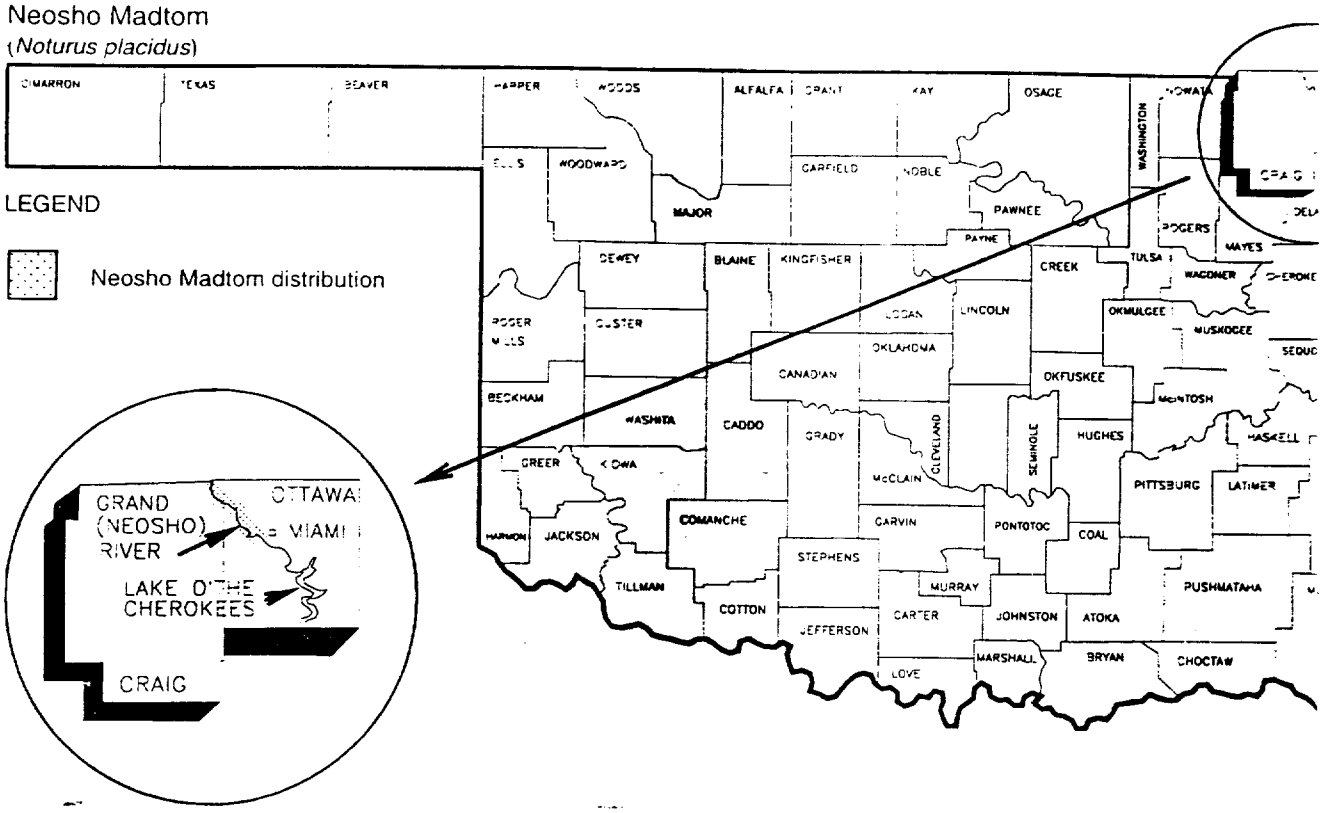
CAUSES OF DECLINE: The Neosho madtom has declined due to habitat destruction. Construction of dams, dredging of gravel, and an increase in water demands have contributed to habitat loss. Pollution from cattle feedlot runoff has adversely affected the fish as well.

RECOVERY NEEDS: Top recovery tasks for the Neosho madtom include further investigations on the biology of the fish, protecting current populations, and developing a reintroduction plan.

OTHER INFORMATION: The recovery plan for the Neosho madtom was approved in September of 1991.

Date prepared: April 1992

Neosho Madtom
(*Noturus placidus*)



Species Account

Ozark Cavefish (*Amblyopsis rosae*)

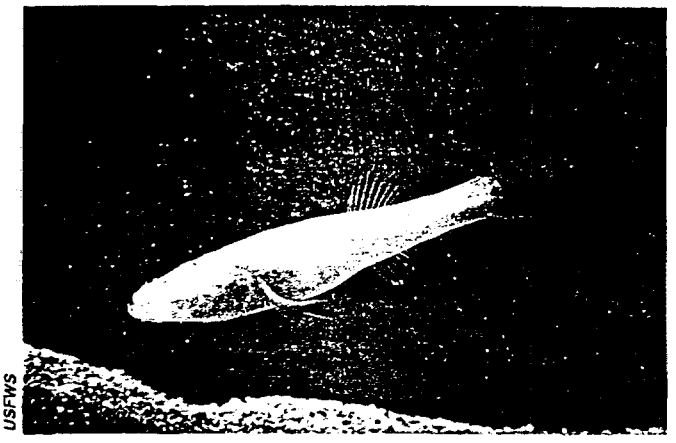
STATUS: Threatened (49 FR 43965; November 1, 1984). Critical habitat has not been designated.

DESCRIPTION: The Ozark cavefish is pinkish-white and reaches a maximum length of two inches (5 cm). The head is flattened, and it has a slightly protruding lower jaw. The fish has no pelvic fin; the dorsal and anal fins are farther back than on most fish. The Ozark cavefish has only rudimentary eyes and no optic nerve.

LIFE HISTORY: The Ozark cavefish lives only in caves. It has no pigmentation and a loss of unused characters. However, it is well adapted to a cave environment through well-developed sensory papillae. They feed primarily on microscopic organisms, as well as small crustaceans and salamander larvae. The reproductive rate of Ozark cavefish is relatively low compared to most other fish.

HABITAT: Caves which have populations of the Ozark cavefish all have a relatively large source of nutrients, such as bat guano or blown leaf litter. Water quality in caves that contain cavefish is usually high. Ozark cavefish are able to tolerate the extremely low oxygen content of ground water found in caves. Cavefish tend to occur in flowing cave streams as opposed to quiet pools.

DISTRIBUTION: The Ozark cavefish is native to the Springfield Plateau of the Ozark Highlands (southwestern Missouri, northwestern Arkansas, and northeastern Oklahoma). Currently, 15 caves in this area have verified cavefish populations. In Oklahoma, populations are known to occur in Delaware County. There are historical records for Ottawa and Mayes counties.



Ozark Cavefish (*Amblyopsis rosae*)

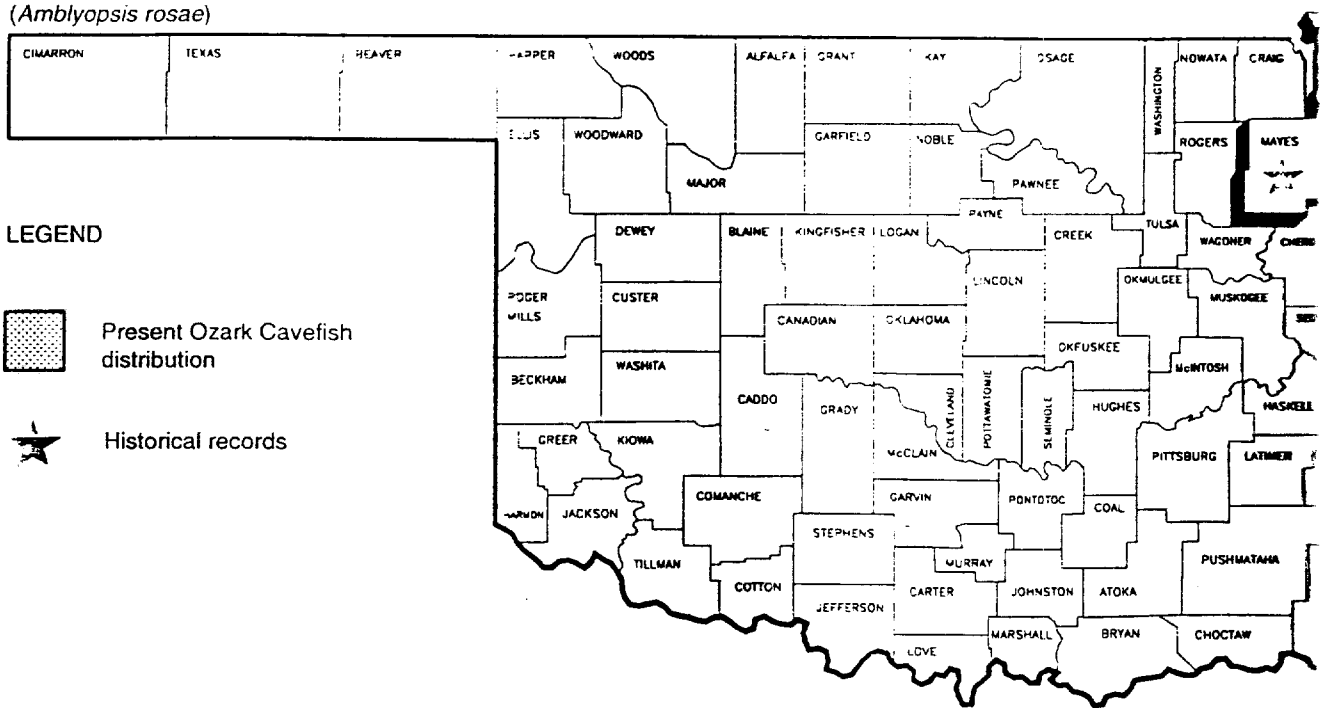
CAUSES OF DECLINE: Factors that have led to the decline of the Ozark cavefish include destruction of habitat, collecting of specimens, and disturbance by spelunkers.

RECOVERY NEEDS: Protection of caves containing cavefish is the most important task. This includes monitoring water quality that flows into caves and erecting fences or gates that limit access by humans, but that do not interfere with bat populations.

OTHER INFORMATION: The states of Arkansas, Missouri, and Oklahoma have each purchased a cave to protect the cavefish. In many caves, the major source of energy for the organisms on which cavefish feed is bat guano. Therefore, Ozark cavefish survival is dependent on the survival of bats, such as the endangered gray bat.

Date prepared: April 1992

Ozark Cavefish
(*Amblyopsis rosae*)



LEGEND

Present Ozark Cavefish distribution

Historical records

Species Account

American Alligator (*Alligator mississippiensis*)

STATUS: Reclassified to threatened due to similarity of appearance in Oklahoma on June 4, 1987 (50 FR 21059). The original classification was endangered (32 FR 4001; March 11, 1967) without critical habitat being designated.

DESCRIPTION: Alligators are large, lizard-like reptiles with broadly rounded snouts. Adults are six (185 cm) to 12 (365 cm) feet long and can reach lengths of 15 (455 cm) or more feet. They are blackish in appearance, but have pale crossbands on the back and vertical markings on the sides.

LIFE HISTORY: Females make nest mounds of grass and mud which insulate the eggs from drastic temperature fluctuations. Mounds may be two feet high and contain 30 to 50 eggs. The female will guard the nest until the young are ready to hatch. Incubation lasts from 60 to 70 days. At the end of incubation, the young begin making "chucking" sounds until the female uncovers the eggs. The young can grow a foot or more each year for several years. Both adults and young feed on a variety of animals, including fish, turtles, and other aquatic organisms.

HABITAT: Alligators inhabit rivers, swamps, estuaries, lakes, and marshes.

DISTRIBUTION: Alligators are found throughout the southeastern United States, from North Carolina to Texas. Oklahoma represents the northwestern most reaches of their range. The historic distribution in Oklahoma was limited to the Red River and Little River drainages in southeastern Oklahoma. Currently, alligators are considered to be an occasional visitor along the Red River in McCurtain County.

CAUSES OF DECLINE: Alligators have declined in numbers due to overhunting and destruction of habitat. The young are at high risk from predation and human disturbance.

Curtis J. Carley

Berlin Heck

Top: American Alligator (*Alligator mississippiensis*). Bottom: American Alligator habitat.

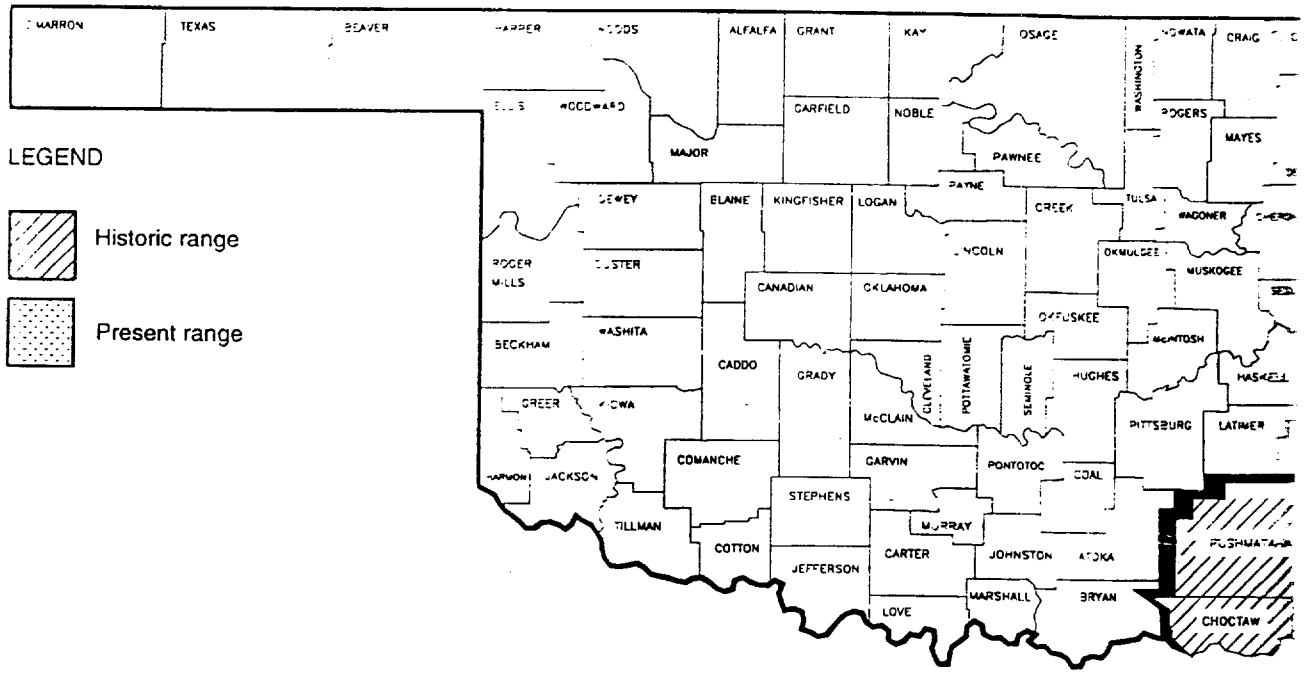
RECOVERY NEEDS: Top recovery tasks for the American alligator have included providing protection for the species (hunting and trade restrictions) and their habitat.

OTHER INFORMATION: American alligator populations have responded well to protection and regulated hunting is now allowed in most states within the alligator's range.

Date prepared: April 1992

American Alligator

(*Alligator mississippiensis*)



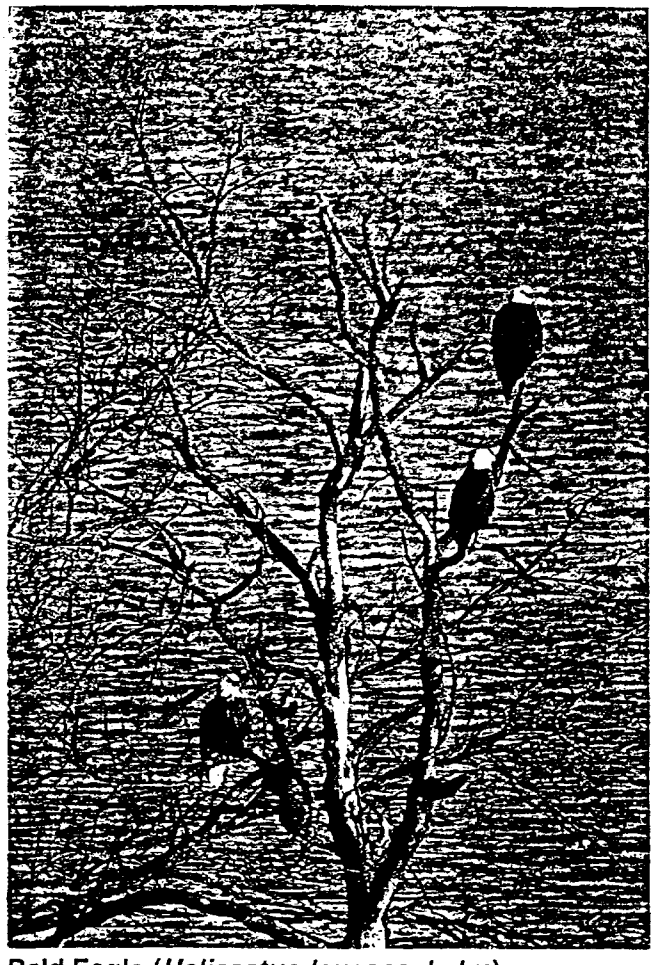
Species Account

Bald Eagle (*Haliaeetus leucocephalus*)

STATUS: Endangered (32 FR 4001, March 11, 1967; 43 FR 6233, February 14, 1978). Critical habitat has not been designated.

DESCRIPTION: The bald eagle is a large bird with a wingspan of 6 to 7.5 feet (180-230 cm). Adults are dark brown with a white head and tail and a large yellow beak. Immatures are dark with mottled white under the wings and at the base of the tail. The feet of both adults and immatures are bare of feathers.

LIFE HISTORY: Bald eagles are long-lived birds and do not achieve full adult plumage for four or five years. Eagles build their nests on the tops of tall trees or on cliffs. Nests can be six feet (180 cm) across and six to eight feet (180-250 cm) high. A pair of eagles will use the same nest year after year. An active nest is one which was attended by a pair even if one of the pair was immature. An inactive nest is one which was not attended by eagles during the year. A winter nest is one that was attended by pairs that disappear at about the same time that the northern wintering eagles migrate north. A productive nest is known to have fledged at least one young. In the southeastern United States, nesting activities may begin as early as September. Typically, two eggs are laid and they hatch after about 35 days. Fledging may take as long as 12 weeks and parents may care for their young for four to six weeks after fledging. Fish are a major component of the bald eagle's diet, but bald eagles will eat a variety of animals, including waterfowl, small mammals, and carrion.



Mike Brooks

Bald Eagle (*Haliaeetus leucocephalus*)

HABITAT: Bald eagles require large trees or cliffs near water with abundant fish for nesting. They winter along oceans, rivers, lakes, or in areas where carrion is present.

DISTRIBUTION: The bald eagle is found throughout North America. In Oklahoma, wintering bald eagles can be seen near large rivers or reservoirs across the state. Wintering eagles are most common in the state between December and March. Historical records indicate that bald eagles once nested in Oklahoma. However, only four nests have been active in the last 10 years—one at the Robert S. Kerr Reservoir in Haskell County, one on the McAlester Ammunition Depot in Pittsburg County, one at Sequoyah National Wildlife Refuge in Sequoyah County, and one in Noble County.

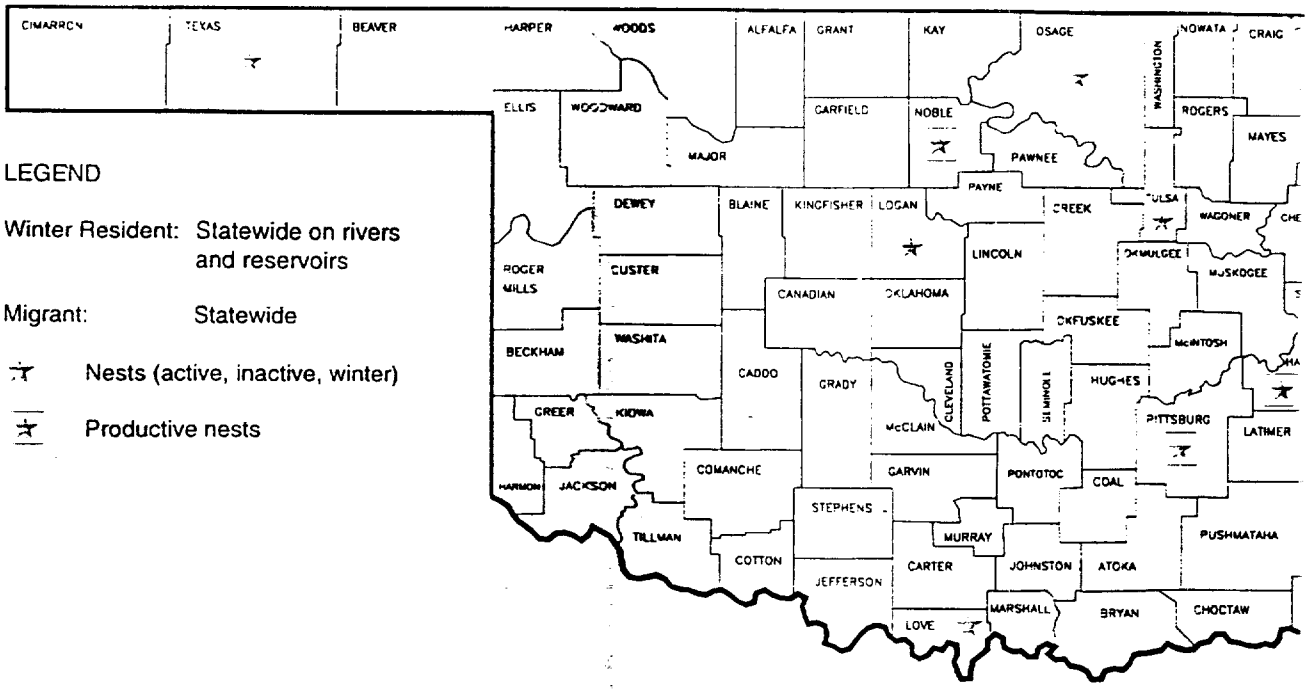
CAUSES OF DECLINE: Bald eagles have declined in numbers due to pesticide-induced reproductive failure, loss of riparian habitat, and human disturbances, such as shooting, poisoning, and trapping.

RECOVERY NEEDS: Recovery needs for the bald eagle population include continued protection and management of their habitat, monitoring eagle populations, and re-establishing breeding populations throughout their historic range.

OTHER INFORMATION: In an effort to establish a breeding population in Oklahoma, more than 90 young bald eagles have been released in Oklahoma since 1985. Nationwide, bald eagle populations have been slowly increasing because of conservation programs.

Date prepared: April 1992

Bald Eagle
(*Haliaeetus leucocephalus*)



LEGEND

Winter Resident: Statewide on rivers and reservoirs

Migrant: Statewide

Nests (active, inactive, winter)

Productive nests

Species Account

American Peregrine Falcon (*Falco peregrinus anatum*)

STATUS: Endangered (35 FR 16047, October 1970; 35 FR 8495, June 2, 1970). Critical habitat has not been designated.

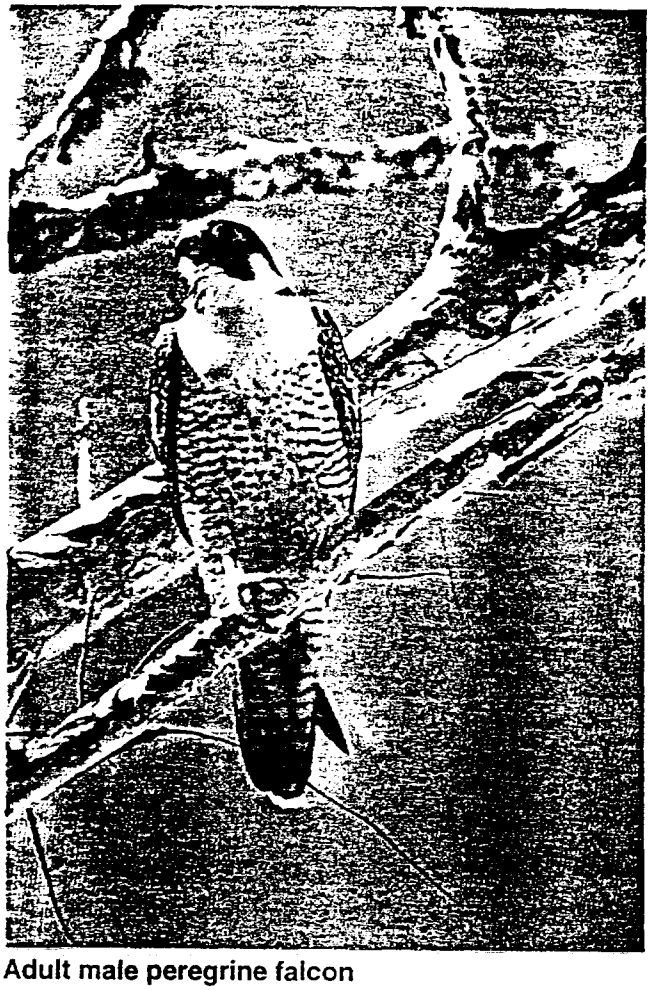
DESCRIPTION: The American peregrine falcon is crow-sized with a wingspan of about 3.5 feet (110 cm). They have a long tail and pointed wings. Peregrines are slate gray or dark brown above and whitish below. Their crown and nape are black. In addition, peregrines have a vertical "bandit's mask" pattern over the eyes. Their dark back separates them from the similar, sandy-brown prairie falcon.

LIFE HISTORY: Peregrine falcons are graceful and powerful fliers. They have been clocked at over 200 m.p.h. while diving after prey. Peregrines begin reproducing when they are three years old. They are monogamous and mate for life. Pairs perform elaborate aerial courtship displays at the start of the breeding season. Three to four eggs typically are laid, but nest failure is common, and juvenile mortality may be very high. Other birds are the primary prey of peregrine falcons.

HABITAT: Peregrine falcons nest on high cliffs, often near water where prey species are most common. They have successfully nested on skyscrapers in large cities where they feed mostly on pigeons.

DISTRIBUTION: Peregrine falcons are nearly worldwide in distribution. The race *Falco peregrinus anatum* once nested over much of North America. Currently, they nest in scattered areas throughout their historic range. Nesting has never been recorded in Oklahoma. However, peregrine falcons migrate through and occasionally winter in Oklahoma. They are most often observed along rivers or near large bodies of water.

CAUSES OF DECLINE: Shooting, human disturbance, and collecting all decreased peregrine falcon numbers. However, reproductive failure caused by pesticides was the major factor that led to their decline.



Tom Smylie, USFWS

Adult male peregrine falcon

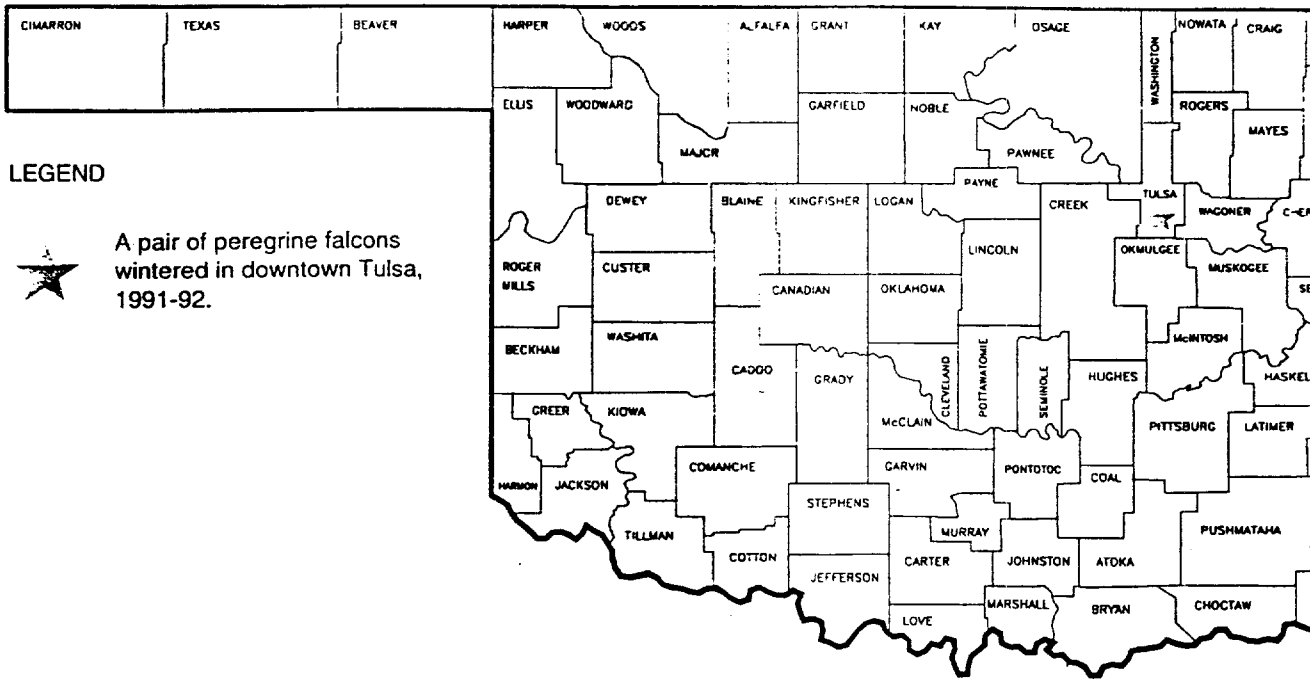
RECOVERY NEEDS: Banning the use of DDT has improved the nesting success of wild peregrine falcons. The primary recovery tasks include the continued measuring of pesticide levels and monitoring nesting success.

OTHER INFORMATION: The peregrine falcon recovery plan was revised in 1984. Much of the recovery progress is due to captive breeding and reintroductions.

Date prepared: April 1992

American Peregrine Falcon

(*Falco peregrinus anatum*)



LEGEND

A pair of peregrine falcons wintered in downtown Tulsa, 1991-92.

Species Account

Arctic Peregrine Falcon (*Falco peregrinus tundrius*)

STATUS: Threatened (49 FR 10520; March 20, 1984). Critical habitat has not been designated.

DESCRIPTION: The Arctic peregrine falcon is very similar to the American peregrine falcon except that it is slightly smaller and paler.

LIFE HISTORY: The life history characteristics of the Arctic peregrine falcon are the same as the American peregrine falcon subspecies.

HABITAT: The Arctic peregrine falcon breeds on the Arctic tundra. In winter, it inhabits coastlines and mountains from Florida to South America.

DISTRIBUTION: The Arctic peregrine falcon breeds on the North American tundra and winters along the Gulf Coast from Florida west to eastern Mexico. It is also found in winter in Baja California, and south to Chile and Argentina. In Oklahoma, it is found statewide during spring and fall migration only.

CAUSES OF DECLINE: The Arctic peregrine falcon has declined because of reproductive failure due primarily to pesticide poisoning.

RECOVERY NEEDS: This species has begun to recover since DDT was banned. Top recovery tasks include continued monitoring of pesticide levels and breeding success.

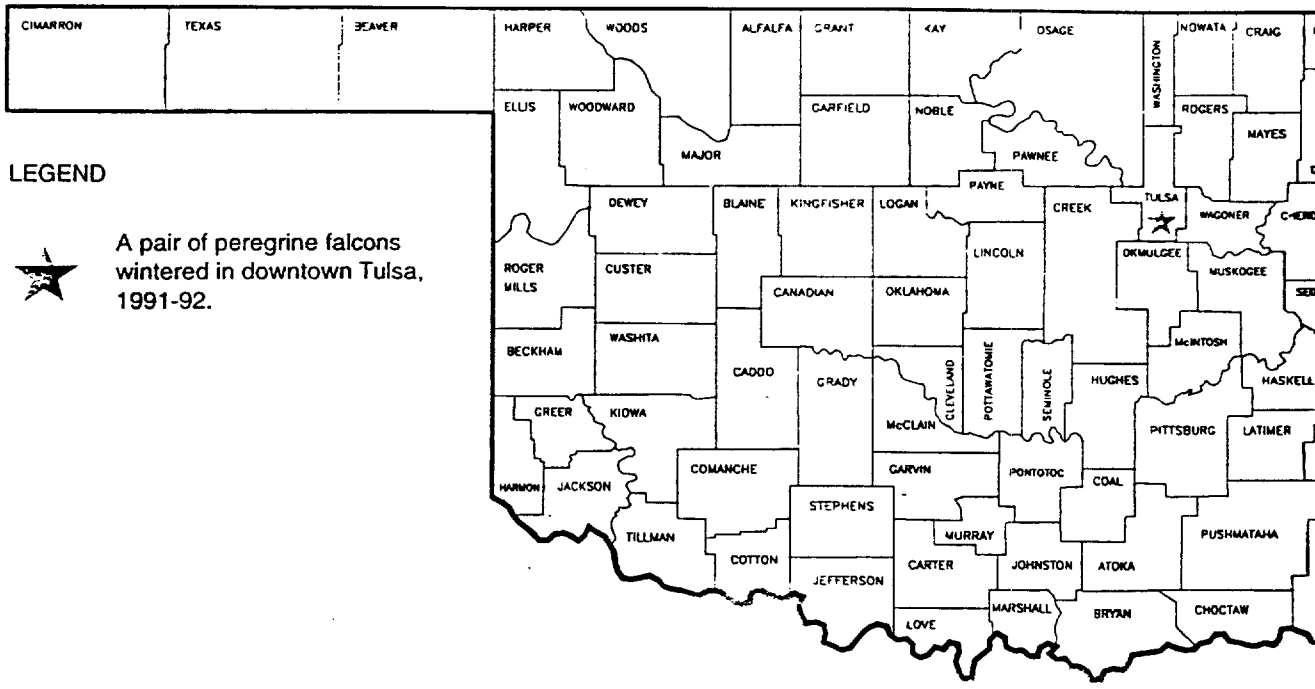
OTHER INFORMATION: The Arctic peregrine falcon was moved from endangered to threatened status in 1984. Population increases are due to reduced pesticide levels in the environment. A recovery team has been appointed, and a recovery plan for Alaska has been approved and is being implemented.

Tom Smylie, USFWS

Adult male peregrine falcon

Date prepared: April 1992

Arctic Peregrine Falcon
(*Falco peregrinus tundrius*)



LEGEND

A pair of peregrine falcons wintered in downtown Tulsa, 1991-92.

Species Account

Whooping Crane (*Grus americana*)

STATUS: Endangered (32 FR 4001, March 11, 1967; 35 FR 8495, June 2, 1970). Critical habitat has been designated (43 FR 20938, May 15, 1978).

DESCRIPTION: At five feet (1.5 m), the whooping crane is the tallest American bird. It is a snowy white, long-necked bird with long legs. Its black primary feathers show only during flight. Adults have a red crown and a patch of black feathers below the eye. Young are whitish overall, but have a rusty-colored head and neck.

LIFE HISTORY: Whooping cranes can live more than 20 years in the wild. They are capable of breeding after three years and mate for life. Nest construction begins in late April. Nests are made of bullrush and are located in tall vegetation near water. Typically, two eggs are laid each year and both parents assist in the care of the young. Young stay with their parents during their first winter. Whooping cranes eat a variety of things, including insects, frogs, small birds, rodents, minnows, and waste grains. Blue crabs and clams are especially important food items on the wintering grounds.

HABITAT: Whooping cranes inhabit marshes and prairie potholes in the summer. In winter, they are found in coastal marshes and prairies.

DISTRIBUTION: Historically, whooping cranes were found from the Northwest Territories in Canada through the prairie provinces and northern prairie states to Illinois. A nonmigratory population existed in Louisiana. The whooping crane formerly wintered in the Carolinas, along the Texas Gulf Coast, and on the intermountain plateau of central Mexico. Currently, an experimental population summers in Idaho and winters in New Mexico. The main population breeds in northern Canada and winters along the Texas Gulf Coast. It passes through western Oklahoma each spring and fall during migration. The Salt Plains National Wildlife Refuge, near Jet, Oklahoma, is a very important migration stopover area. During migration, whooping cranes sometimes are sighted elsewhere in Oklahoma along rivers, in grain fields, or in shallow wetlands.

CAUSES OF DECLINE: Whooping cranes have declined primarily because of loss of wintering and breeding habitat. Shooting and collisions with powerlines or fences have been sources of mortality in recent years.

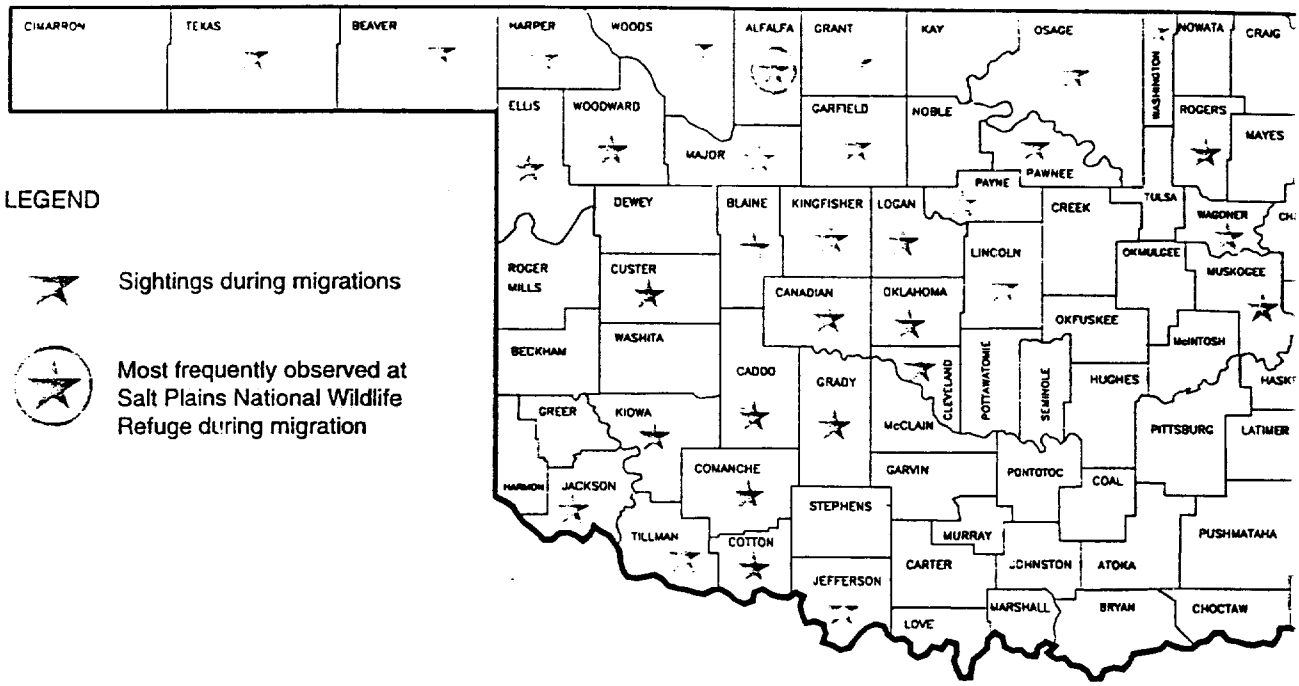
Whooping Crane (*Grus americana*)

RECOVERY NEEDS: Top priorities for whooping crane recovery include increasing the main wild population to a minimum of 40 breeding pairs, increasing captive breeding efforts, and establishing at least two new wild populations.

OTHER INFORMATION: By the mid 1940s, only 15 whooping cranes were present in the wild. An intensive captive-breeding program and careful protection of wild flocks have slowly increased the number in the wild to more than 120.

Date prepared: April 1992

Whooping Crane
(*Grus americana*)



LEGEND

Sightings during migrations

Most frequently observed at Salt Plains National Wildlife Refuge during migration

Species Account

Piping Plover (*Charadrius melodus*)

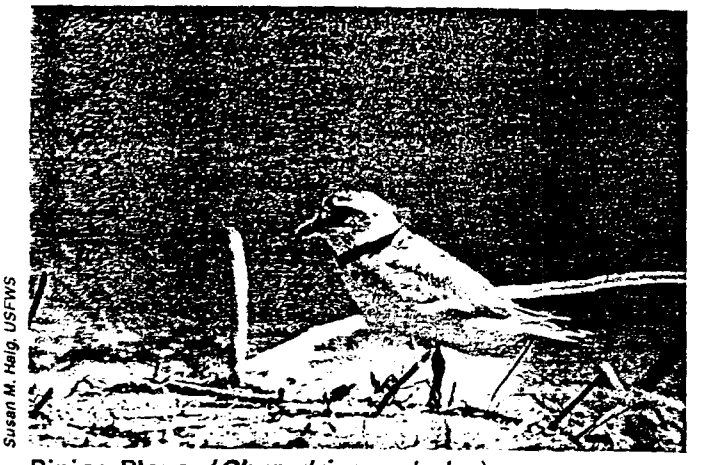
STATUS: Endangered in the watershed of the Great Lakes, threatened in the remainder of its range (50 FR 50726; December 11, 1985). Critical habitat has not been designated.

DESCRIPTION: The piping plover is a small shorebird about seven inches (18 cm) long with a wingspan of about 15 inches (38 cm). Adults have sand-colored upper parts and white undersides. During the breeding season, piping plovers have a single dark band across the breast and forehead. They can be distinguished from similar species by their bright orange legs.

LIFE HISTORY: Piping plovers arrive on their breeding grounds along the Atlantic Coast in late March and on their prairie breeding grounds in early May. Males defend territories and attract females with aerial displays. Piping plovers are monogamous and both parents participate in all stages of parental care. Four eggs are typically laid in a shallow nest scrape and hatching occurs 25 to 31 days after completion of the clutch. Adults depart from breeding areas as early as the first week in July. Piping plovers feed on a variety of invertebrates, including worms, crustaceans, and insects.

HABITAT: Piping plovers nest on sandy beaches along the ocean or lakes. Along rivers, piping plovers use the bare areas of islands or sandbars. They also nest on the pebbly mud of interior alkali lakes and ponds. Birds nesting on gravel have higher reproductive success than those nesting on alkali. During the winter, piping plovers use algal, mud, and sand flats along the Gulf Coast. Spoil islands in the intracoastal waterway are also used.

DISTRIBUTION: Historically, piping plovers bred along the Atlantic Coast, on the northern Great Plains, and around the Great Lakes. Piping plovers winter along the southern Atlantic and Gulf coasts, and in the Bahamas and West Indies. Although drastically reduced, remnant populations occur throughout their historic range. Piping plovers migrate through Oklahoma each spring and fall.



Susan M. Haig, USFWS

Piping Plover (*Charadrius melodus*)

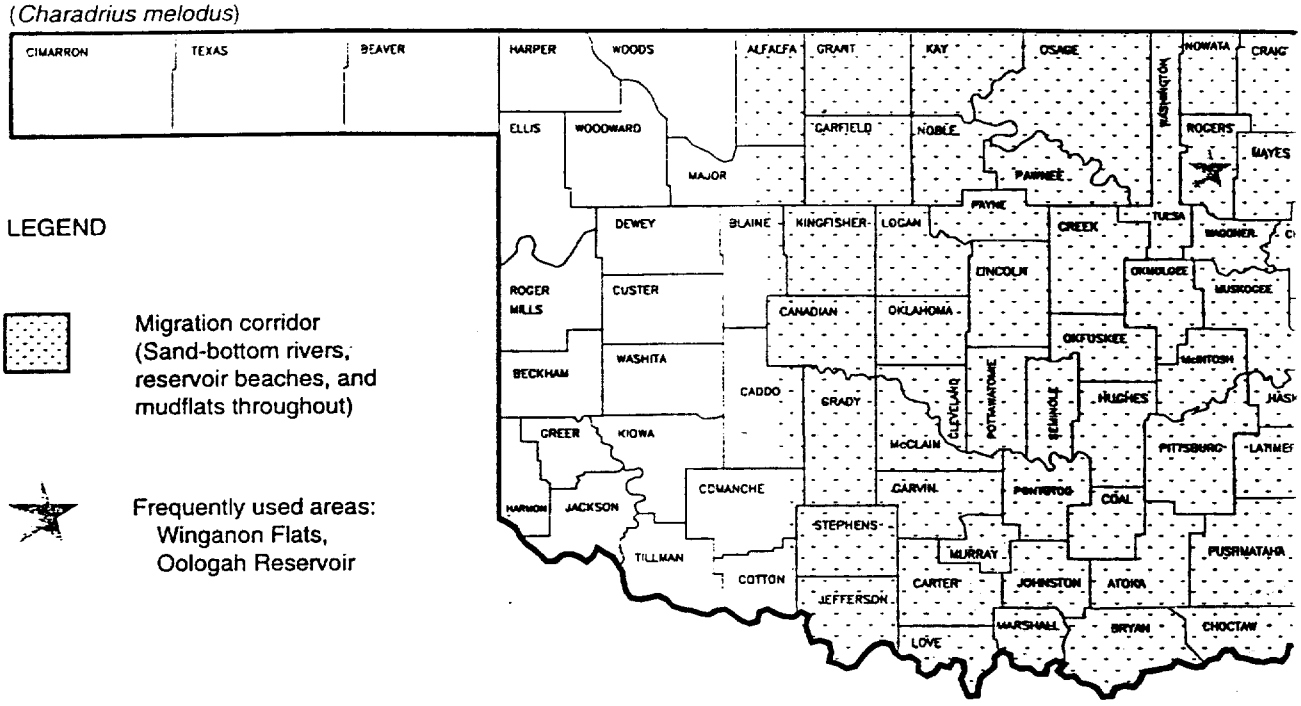
CAUSES OF DECLINE: Piping plovers have been drastically reduced in number, due to the loss of beach habitat and to the modification of habitat through the channelization and damming of rivers. These practices eliminate sandbars and allow the growth of vegetation on nesting areas. Nesting success of piping plovers on beaches used by humans is much lower than on isolated beaches because of disturbance.

RECOVERY NEEDS: Top needs for piping plover recovery include monitoring population trends, managing and protecting populations and their habitat, and further research on the general ecology of the species.

OTHER INFORMATION: The piping plover recovery plan was completed in 1988. Hunters almost eliminated the species in the early 1900s. However, because of strict protection, populations recovered by the 1940s. The current decrease in numbers has resulted from habitat loss. Currently, the population of piping plovers is estimated at approximately 5,000 individuals.

Date prepared: April 1992

Piping Plover
(*Charadrius melodus*)



LEGEND

Migration corridor (Sand-bottom rivers, reservoir beaches, and mudflats throughout)

Frequently used areas: Winganon Flats, Oologah Reservoir

Species Account

Interior Least Tern (*Sterna antillarum*)

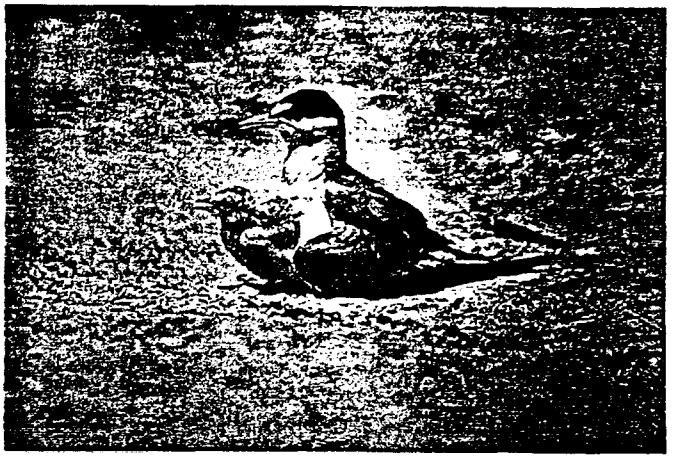
STATUS: Endangered (50 FR 21784; May 28, 1985). Critical habitat has not been designated.

DESCRIPTION: The least tern is the smallest member of the tern family with a wingspan of 20 inches (50 cm). They have a grayish back and wings, and snowy white undersides. Least terns can be distinguished from all other terns by their combination of a black crown, white forehead, and a variable black-tipped yellow bill.

LIFE HISTORY: Least terns arrive at breeding sites from late April to early June where they typically spend four to five months. Pairs go through an elaborate courtship period that includes courtship feedings, and a variety of postures and vocalizations. Least terns nest in small colonies on exposed salt flats, river sandbars, or reservoir beaches. Nests are small scrapes in the sand and usually two or three eggs are laid. The young are fairly mobile soon after hatching. Both parents feed the young and remain with them until fall migration. Terns will travel four or more miles (6+ km) from their breeding colonies to find the small fish that make up the major part of their diet.

HABITAT: Interior least terns favor islands or sandbars along large rivers for nesting. The sand must be mostly clear of vegetation to be used by terns. Least terns prefer shallow water for fishing. Water levels must be low enough so that nests stay dry.

DISTRIBUTION: The historic distribution of the interior least tern was the major river systems of the midwestern United States. These rivers included the Red, Rio Grande, Arkansas, Missouri, Ohio, and Mississippi river systems. Currently, they occur as small remnant colonies throughout their former range. In Oklahoma, interior least terns nest along most of the larger rivers, as well as at the Salt Plains National Wildlife Refuge near Jet, Oklahoma. Least terns winter in South America.



Ginny Brubeck, USFWS

Interior Least Tern (*Sterna antillarum*)

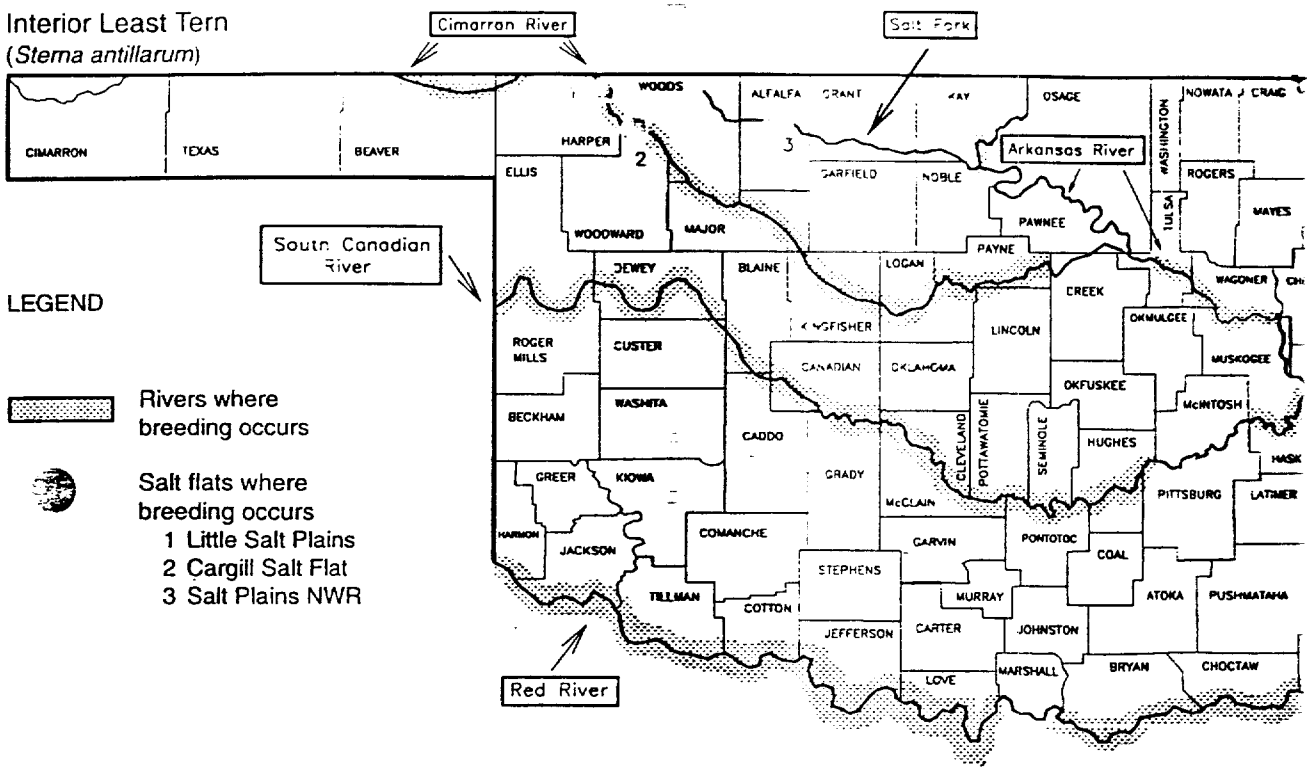
CAUSES OF DECLINE: Many nesting areas have been permanently flooded by reservoirs and channelization projects. Unpredictable water discharge patterns below dams flood nesting areas. Overgrowth of brush and trees also eliminates remaining habitat. This prevents terns from using these areas as nesting sites. The recreational use of sandbars by humans is a major threat to the tern's reproductive success.

RECOVERY NEEDS: Primary recovery tasks for least tern populations include determining population trends and habitat requirements, increasing breeding populations, and developing public awareness of the needs of least terns through educational programs.

OTHER INFORMATION: The recovery plan for the interior least tern was released in 1990. The United States Fish and Wildlife Service is working with various state and federal agencies to monitor and protect the least tern. In Oklahoma, they are working with the Nature Conservancy to protect tern habitat along the Arkansas River near Tulsa, and along the Canadian River near Norman.

Date prepared: April 1992

Interior Least Tern
(*Sterna antillarum*)



LEGEND

Rivers where breeding occurs

Salt flats where breeding occurs

1 Little Salt Plains
2 Cargill Salt Flat
3 Salt Plains NWR

Species Account

Red-cockaded Woodpecker (*Picoides borealis*)

STATUS: Endangered (35 FR 8495; June 2, 1970). Critical habitat has not been designated.

DESCRIPTION: The red-cockaded woodpecker averages about 7.25 inches (20 cm) long. It has a black-and-white barred back and a solid black cap and nape. It has prominent white cheek patches. The male has a tiny red tuft behind the eye near the ear (the cockade). The call notes of the red-cockaded woodpecker are raspy and nasal sounding.

LIFE HISTORY: Red-cockaded woodpeckers live in extended family groups known as clans. Clans consist of a single breeding pair, young birds, and sons of the breeding male. The entire clan helps in territory defense. The breeding male can live for several years. When he dies, one of his sons typically inherits the breeding territory. Red-cockaded woodpeckers breed from late April to July. The breeding female lays between two and four eggs, and all members of the clan help incubate and feed the young. Red-cockaded woodpeckers eat various insects, spiders, and other invertebrates found under bark and in the dead limbs of trees.

HABITAT: Red-cockaded woodpeckers live in old-growth (60-70+ years) loblolly, shortleaf, and especially slash and longleaf pine forests. Nesting and roosting cavities are made only in living pine trees over 60 years old. These trees produce large amounts of resin around the woodpeckers' cavity. The resin is thought to discourage potential predators, such as the black rat snake, from climbing the tree and attacking the woodpeckers. Ideal colony sites are located in parklike stands of pines with little or no understory growth. Foraging habitat of the woodpecker includes extensive pine or pine-hardwood forests. Fire plays an important part in maintaining red-cockaded woodpecker habitat by eliminating hardwood undergrowth.

DISTRIBUTION: The historic distribution of the red-cockaded woodpecker included the southeastern United States. They ranged from Florida north to Virginia and west to eastern Texas and Oklahoma. In Oklahoma, they were restricted to the shortleaf pine area of southeastern Oklahoma. The red-cockaded woodpecker once occupied Bryan, Latimer, LeFlore, McCurtain, Pittsburg, and Pushmataha counties. The current distribution in Oklahoma includes only a limited area of McCurtain and Pushmataha counties. The Pushmataha colony was inactive in 1992.

Outdoor Oklahoma, Oklahoma Dept. of Wildlife Conservation

Red-cockaded Woodpecker (*Picoides borealis*)

CAUSES OF DECLINE: Red-cockaded woodpeckers have declined primarily due to the loss of suitable habitat. Short-term-rotation timber management of private and public forests has eliminated much of the old-growth pine forest necessary to maintain healthy woodpecker populations.

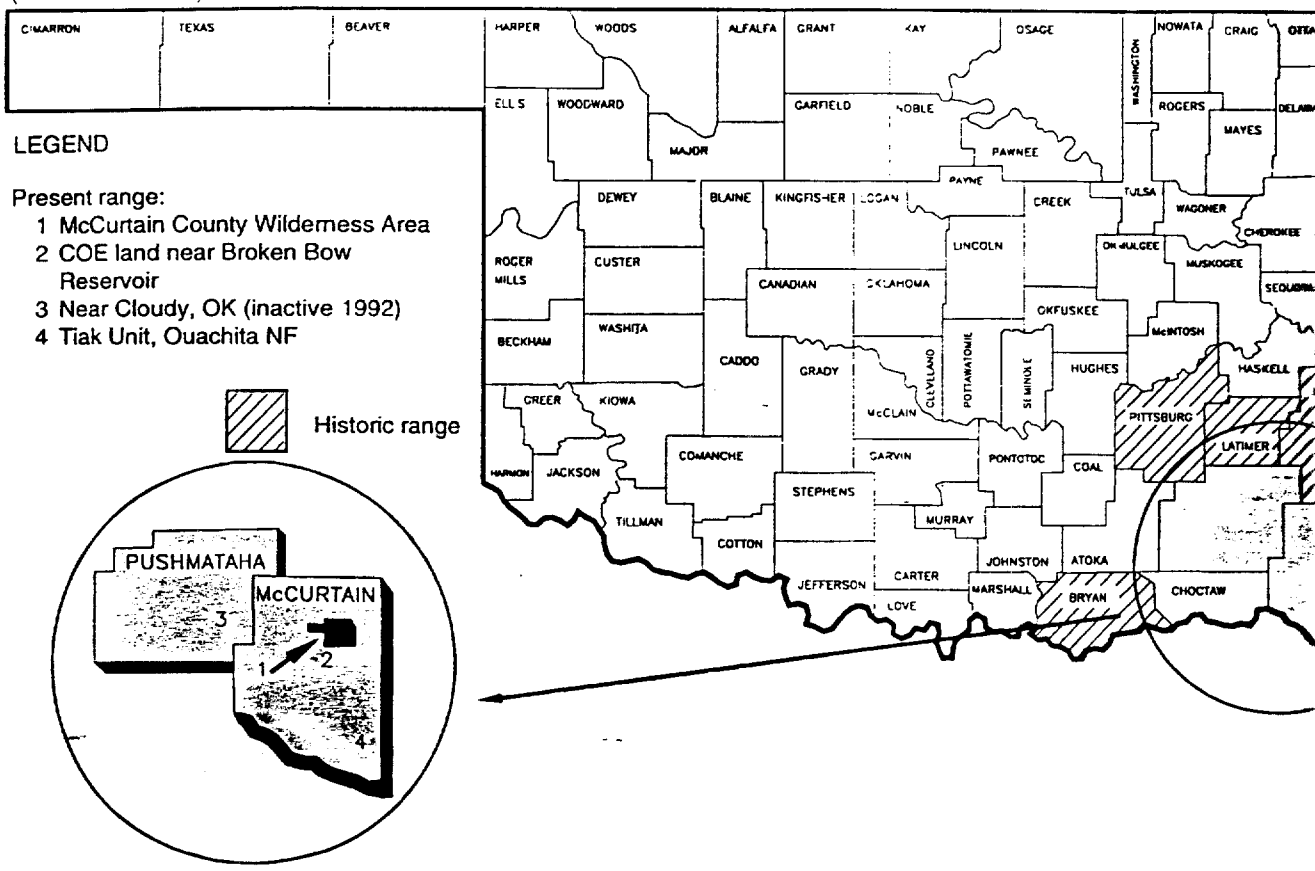
RECOVERY NEEDS: The top recovery tasks for the red-cockaded woodpecker include continued monitoring of individual populations, protecting and managing woodpecker habitat on public and private land, and continued research of red-cockaded woodpecker ecology.

OTHER INFORMATION: The construction of artificial cavities shows promise as a useful management technique for establishing new colonies. The original recovery plan was revised in 1985.

Date prepared: April 1992

Red-cockaded Woodpecker

(*Picoides borealis*)



Species Account

Black-capped Vireo (*Vireo atricapillus*)

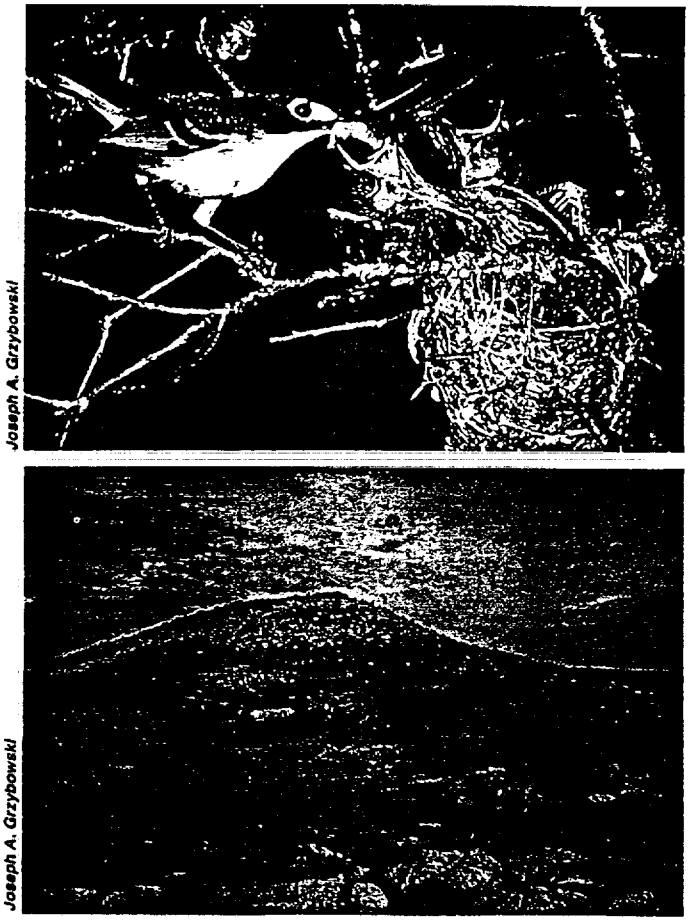
STATUS: Endangered (54 FR 37420; October 6, 1987) without critical habitat.

DESCRIPTION: The black-capped vireo is a songbird about 4.5 inches (12 cm) in length. Sexually mature males are olive green above and white below with faint yellow flanks. The crown and upper half of the head is black with a partial white eye-ring and lores. The iris is brownish-red and the bill is black. Females are duller in color than males and have a slate gray crown and underparts washed with greenish yellow. First year males are intermediate in coloration between adult males and females.

LIFE HISTORY: The male and female in a pair assist in nest construction and incubation. The female broods the young, while the male supplies most of the food during the nestling phase. Typically, three to four eggs are laid. The incubation period is 14 to 17 days, and the nestling period is 10 to 12 days. Breeding pairs are capable of producing more than one clutch per breeding season. The male cares for some or all of the fledglings, while the female re-nests—sometimes with another male. These birds are insectivorous, with beetles and caterpillars making up a large part of the diet.

HABITAT: Black-capped vireo habitat consists of scattered trees and brushy areas. The presence of oak trees appear to be more important to the vireo than junipers. Foliage that extends to ground level is the most important requirement for nesting. Most nests are between 15 and 50 inches (35-125 cm) above ground level and are screened from view by foliage. Territories are sometimes located on steep slopes, where trees are often clumped and intermediate in height. On level terrain, preferred black-capped vireo habitat is a mixture of shrubs and smaller trees that average from eight to 10 feet high (2.5-3.5 m). Black-capped vireos will no longer use sites where many trees are nearing full size.

DISTRIBUTION: The historic breeding distribution of the black-capped vireo extended south from south-central Kansas through central Oklahoma and Texas to central Coahuila, Mexico. At present, the range extends from Oklahoma south through the Edwards Plateau and Big Bend National Park, Texas, to at least the Sierra Madera in central Coahuila, Mexico. In Oklahoma, the black-capped vireo is found only in Blaine, Canadian, Caddo, and Comanche counties. The winter range of the black-capped vireo is not well known. It is thought to winter along the west coast of Mexico from southern Sonora to Guerrero.



Top: Black-capped Vireo (*Vireo atricapillus*).
Bottom: Black-capped Vireo habitat.

CAUSES OF DECLINE: The black-capped vireo is threatened by brown-headed cowbird (*Molothrus ater*) nest parasitism, human disturbance, and loss of habitat to urbanization, fire exclusion, grazing, and brush control.

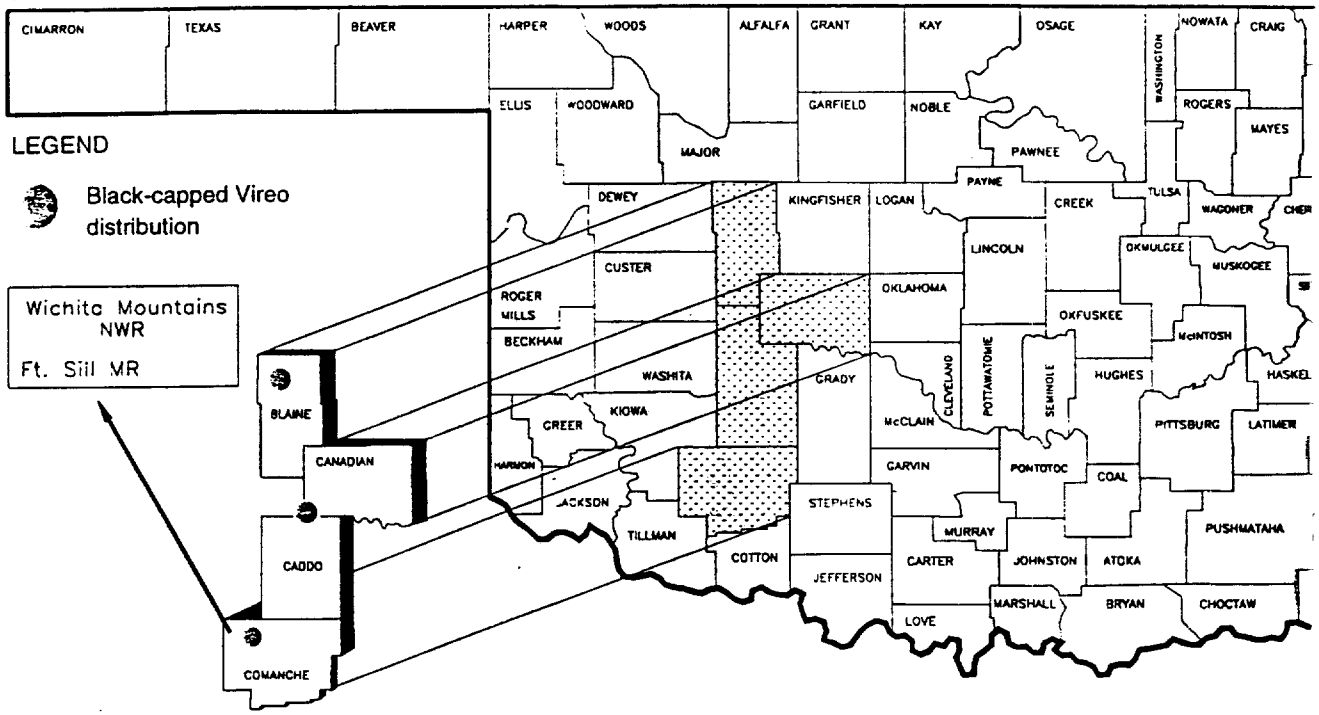
RECOVERY NEEDS: The top recovery tasks for the black-capped vireo include: 1) determining where cowbirds pose a threat and controlling their numbers in vireo breeding areas, 2) determining threats to vireo winter habitat, and 3) determining how to manage habitat for the vireo.

OTHER INFORMATION: Ongoing projects in Texas and Oklahoma to recover the black-capped vireo include extensive cowbird trapping and cowbird egg removal from nests. Studies on the nesting ecology and population dynamics of the black-capped vireo are also contributing to our understanding of the species.

Date prepared: November 1991

Black-capped Vireo

(*Vireo atricapillus*)



Species Account

Ozark Big-eared Bat (*Plecotus townsendii ingens*)

STATUS: Endangered (44 FR 69208; November 4, 1979) without critical habitat.

DESCRIPTION: The Ozark big-eared bat is the largest and reddest of the five subspecies of *P. townsendii.* The species is medium-sized and weighs from 0.2 to 0.5 ounces (5-13 g). It has very large (over 1 inch; 2.5 cm) ears that connect at the base across the forehead. The snout has prominent lumps. The Ozark big-eared bat closely resembles the eastern big-eared bat, but has tan instead of whitish underparts and brown instead of gray dorsal hair.

LIFE HISTORY: The Ozark big-eared bat uses caves all year around. Migration distances between hibernation and summer caves are known to range from four to 40 miles (6.5-65 km). Big-eared bats mate in the fall and store the sperm during the winter. Pregnancy occurs in the spring at the end of hibernation. Ozark big-eared bats give birth to a single offspring. Young bats grow quite rapidly and are capable of flight at three weeks and are weaned by six weeks. Ozark big-eared bats feed on moths and other insects.

HABITAT: Caves used by Ozark big-eared bats are located in karst regions dominated by oak-hickory or beech-maple-hemlock forests. The temperature of hibernation caves ranges from 40° to 50°F (4-9°C). Maternity colonies are located in caves that range in temperature between 50° and 59°F (10-15°C). Ozark big-eared bats forage along forest edge.

DISTRIBUTION: The distribution of the Ozark big-eared bat was probably limited to northwestern Arkansas, neighboring Oklahoma and Missouri. In Oklahoma, this subspecies is known to occur in Adair, Cherokee, Delaware, and Ottawa counties. There is a historical record for Sequoyah County.

Brenda Clark

Ozark Big-eared Bat (*Plecotus townsendii ingens*)

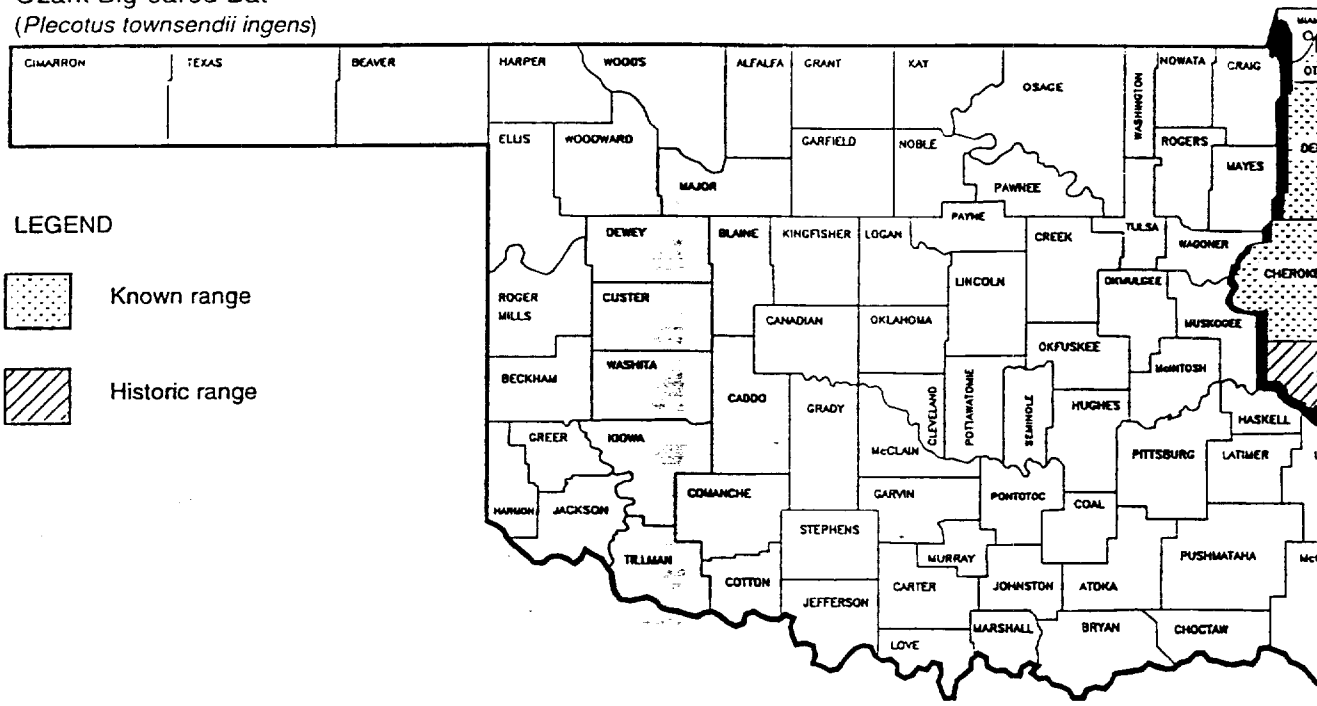
CAUSES OF DECLINE: The Ozark big-eared bat was probably never very common. The species is intolerant of human disturbance, which causes them to abandon favorite roosts. Disturbance of hibernating bats causes them to use valuable fat stores and increases the probability of starvation during the winter. Disturbance of maternity colonies can cause significant mortality of the young.

RECOVERY NEEDS: The top recovery needs of the Ozark big-eared bat include: 1) monitoring of known populations and locating additional ones; and 2) protecting caves from human disturbance and vandalism.

OTHER INFORMATION: Gates or fences erected at cave entrances have been successful in protecting bats. A recovery plan was approved in 1984 and a revised draft is currently under preparation.

Date prepared: February 1992

Ozark Big-eared Bat
(*Plecotus townsendii ingens*)



LEGEND

Known range

Historic range

000598

Species Account

Indiana Bat (*Myotis sodalis*)

STATUS: Endangered (32 FR 4001; March 11, 1967) with critical habitat designated.

DESCRIPTION: The Indiana bat is medium-sized. Its fur is dull gray and chestnut in color. The basal portion of the hairs of the back are a dull lead color. The calcar (the bone attached to the foot) is strongly keeled.

LIFE HISTORY: Indiana bats are migratory. Approximately 85 percent of the known population hibernates in just seven caves. Indiana bats mate in the fall and begin to enter hibernation in October. Males tend to be active longer into the fall, but are in hibernation by late November. Sperm is stored during the winter and females become pregnant soon after emergence in late March and early April. Young are born in June and July. Females and their young roost in small colonies (50 to 100 individuals) under tree bark during the summer months. Colonies are usually located along streams where the bats forage for flying insects. Not much is known about male roosting behavior. Young bats are able to fly approximately a month after birth.

HABITAT: For hibernation, Indiana bats need limestone caves with stable temperatures of 39° to 46°F (4-8°C) and 66 to 95 percent humidity. Low cave temperatures allow the bats to maintain a low metabolic rate throughout hibernation. Only a small percentage of caves meets the specific conditions required by Indiana bats. During the summer, they can be found under bridges, in old buildings, under tree bark, or in hollow trees. Indiana bats forage above small- to medium-sized streams. Streams lined with large, overhanging trees are preferred.

DISTRIBUTION: The Indiana bat is found primarily in the midwestern and eastern United States. The largest populations are in Arkansas, Indiana, Kentucky, Missouri, and Tennessee. Eastern Oklahoma is the western limit of its range. The present Oklahoma range includes Adair, Delaware, LeFlore, and Pushmataha counties. It is now rare in Oklahoma, and usually only scattered individuals are found. They may be in company with gray bats.

CAUSES OF DECLINE: Indiana bats are subject to both natural and human threats. Periodic flooding of winter caves and the collapse of cave or mine ceilings both pose threats. However, the most serious threat to Indiana bats is the disturbance of hibernating colonies by spelunkers or vandals. The commercialization of roosting caves, pesticides, and the channelization of streams also pose threats to the species.

Merlin D. Tuttle

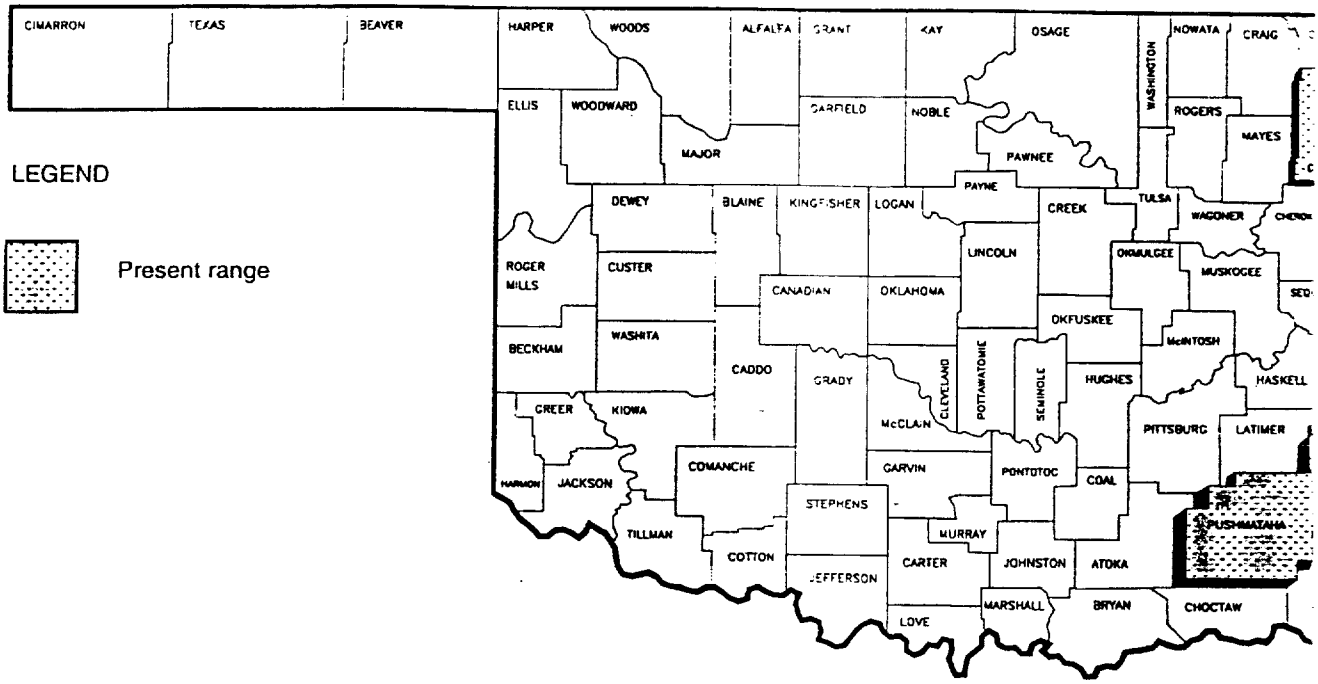
Indiana Bat (*Myotis sodalis*)

RECOVERY NEEDS: The top recovery tasks for the Indiana bat include: 1) preventing disturbance to important winter caves by erecting warning signs and fences or gates, 2) protecting foraging areas and nursery roost habitat from destruction, and 3) educating the public of the consequences of disturbing hibernating bats and of the importance of bats in nature.

OTHER INFORMATION: Indiana bats hibernate from October to April and caves containing Indiana bats should not be entered during this time. Disturbance of hibernating bats is a major cause of the decline of the species. A recovery team has been appointed and the recovery plan was revised in 1983.

Date prepared: February 1992

Indiana Bat
(*Myotis sodalis*)



LEGEND

Present range

Species Account

Gray Bat (*Myotis grisescens*)

STATUS: Endangered (41 FR 17740; April 28, 1976). Critical habitat not designated.

DESCRIPTION: The gray bat is a medium-sized bat with a wingspan of 10 to 11 inches (25-28 cm). It has grayish-brown fur and is the only bat in its range with unicolored dorsal hairs. The dorsal hairs of other bats within its range are bi- or tricolored. The wing membrane of the gray bat connects at the ankle instead of the base of the first toe as in other members of the genus.

LIFE HISTORY: Gray bats migrate each year between winter and summer caves. Mating occurs at winter caves in September. After copulation, females enter hibernation—males and juveniles continue feeding for several weeks. By early November, most gray bats are in hibernation. Adult females begin to emerge in late March, followed by juveniles and adult males. Females store sperm during the winter and become pregnant after emerging in the spring. A single offspring is born in late May or early June. Young begin to fly 20 to 25 days after birth. Gray bats feed on flying insects over bodies of water. Mayflies make up the major part of their diet.

HABITAT: Gray bats almost always roost in caves year-round. Historically, hibernation caves could contain well over a million individuals. Summer colonies can reach 250,000 individuals. Gray bats have very specific cave requirements. As a result, fewer than five percent of available caves are suitable. Winter caves must be very cold with a range in temperature between 42° and 52°F (6-11°C). Winter caves are deep with vertical walls. Summer caves must be warm (57-77°F or 14-25°C) or with restricted rooms that can trap the body heat of roosting bats. Summer caves are located close to rivers or lakes where the bats feed. Bats are known to range at least 12 miles (20 km) from their colony to feed.

DISTRIBUTION: Gray bat distribution is limited to limestone cave areas of the southeastern United States. Major populations are found in Alabama, Arkansas, Kentucky, Missouri, and Tennessee. Smaller populations may occur in surrounding states. In Oklahoma, the historic distribution probably was limited to the limestone region of the northeastern part of the state. At present, this bat is found in only four counties in northeastern Oklahoma—Adair, Cherokee, Delaware, and Ottawa. Gray bats may occur in caves in other counties, but there have been no recent sightings. No hibernation caves are known in Oklahoma.

Merlin D. Tuttle

Gray Bat (*Myotis grisescens*)

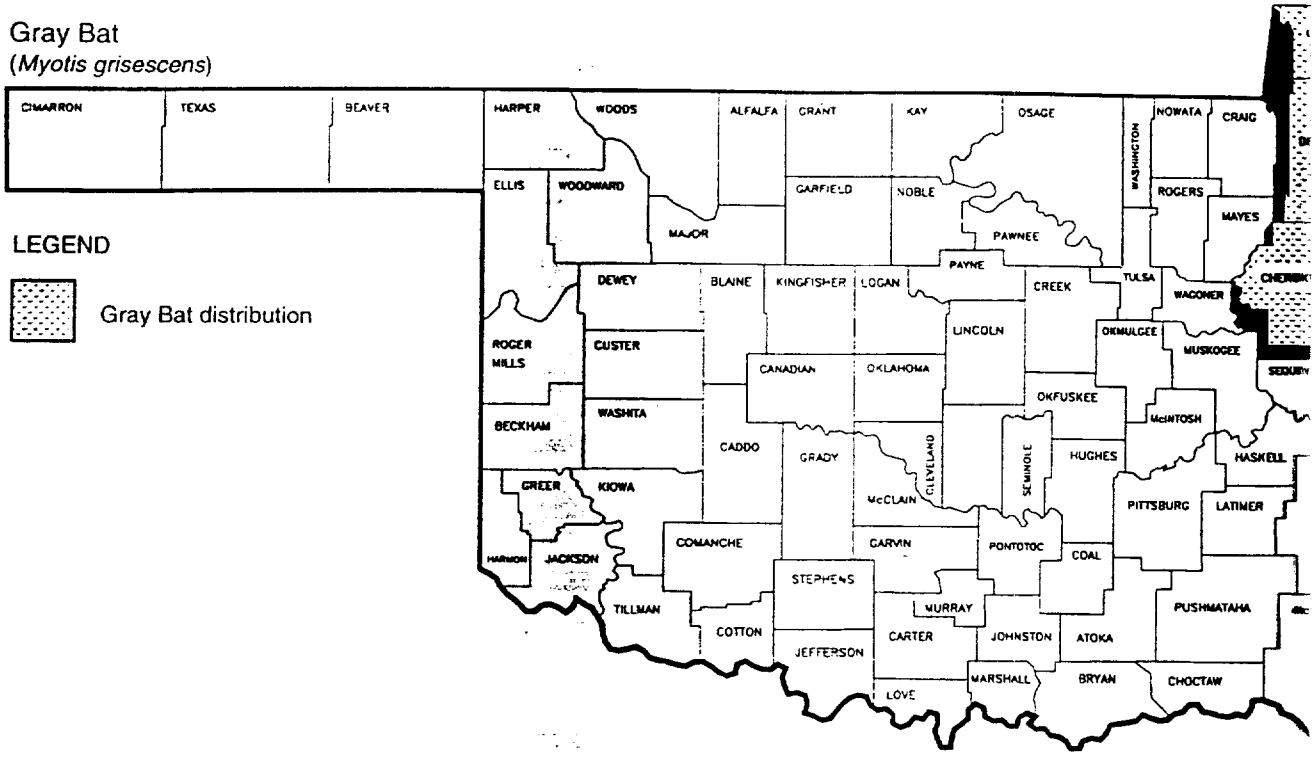
CAUSES OF DECLINE: The gray bat is extremely vulnerable to human disturbances at roosting caves. This is especially true at hibernation and maternity caves. The gray bat also is threatened by pesticides, loss of habitat due to flooding by man-made impoundments, commercialization of caves, and improper gating of caves.

RECOVERY NEEDS: The top recovery tasks for the gray bat include: 1) acquiring and protecting caves; 2) controlling habitat destruction; and 3) educating the public about the danger human disturbance represents to the bat and about the ecological importance of the gray bat.

OTHER INFORMATION: Human disturbance at winter caves is energetically costly for bats and can significantly decrease their chances of surviving the winter. Disturbance of maternity caves in the summer can cause large-scale mortality of flightless young. Gates, fences, and signs are often used to keep people out of active gray bat caves.

Date prepared: January 1992

Gray Bat
(*Myotis grisescens*)



LEGEND

Gray Bat distribution

Appendix 1

The Endangered Species Process

The Listing Process

To list a species, the U.S. Fish and Wildlife Service follows a strict legal process to propose and later to adopt regulations that have the effect of law. The USFWS first publishes notices of review that identify U.S. species considered as "candidates" for listing. A priority system (based on degree and immediacy of threat and taxonomic factors) has been developed to direct efforts toward plants and animals with the greatest need for protection.

By law, listing decisions must be based solely on the best available biological data. Generally (but not always), the USFWS requires information on a species' distribution, biology, and threats in order to make a listing decision.

Although the USFWS usually initiates listing proposals, such actions may also start as a recommendation or petition from knowledgeable individuals or organizations. Any person may suggest that a species be listed, but adequate information must be presented for the USFWS to make a positive listing decision. As part of the listing process, the USFWS must decide if a species should be proposed for listing as endangered or threatened. An endangered species is one in danger of extinction throughout all or a significant portion of its range. A threatened species is one likely to become endangered within the foreseeable future.

Once a species has been chosen for possible listing, preproposal letters of inquiry are sent to species experts, federal and state agencies, and other interested organizations and individuals. If biological information supports the decision to continue the listing process, a proposed rule is then published in the Federal Register. All interested parties are encouraged to comment and provide additional information and submit statements at any public hearings that may be held. The comment period is usually 60 days, and the public has 45 days to request a public hearing.

Within one year of publication of a listing proposal, one of three possible courses of action must be taken:

1) A final listing rule is published;

2) If the available biological information does not support the listing, the proposal is withdrawn; or

3) If, at the end of one year, there is substantial disagreement within the scientific community concerning the biological justification of the listing, the proposal may be extended for a maximum of six months. After that time, a decision must be made on the basis of the best scientific information available.

If approved, the final listing rule generally becomes effective 30 days after publication in the Federal Register. After a species is listed, its status is reviewed at least every five years to determine if federal protection is still warranted.

The Consultation Process

Section 7 of the Endangered Species Act requires that all federal agencies consult with the USFWS on endangered and threatened species. This consultation requirement involves all actions authorized, funded, or carried out by federal agencies. There are two categories of consultations—informal and formal.

Informal Consultation Steps:

- Federal agency (or designated agent) contacts the USFWS for a list of endangered or threatened species in the project area and/or for information on the species.
- Federal agency (or designated agent) then makes a determination on whether the proposed action "may affect" the listed species. They may prepare a biological assessment to help make this determination.
- If it is determined by the federal agency or agent (and agreed upon by the USFWS) that the action would have no effect on the listed species, then no further consultation is necessary.
- If it is determined that the proposed action may affect listed species, then the federal action agency must initiate formal consultation with the USFWS.

Formal Consultation Steps:

- The federal action agency initiates formal consultation with the USFWS in writing, and includes a description of the proposed action, the specific area of the proposed action, any federally listed species that may be affected by the action, how the proposed action may affect the listed species, and any other information available.
- The USFWS has up to 90 days to complete a biological opinion on the effects of the action on listed species. The purpose of the biological opinion is to determine whether or not the project will jeopardize the continued existence of a listed species or adversely modify its

critical habitat. Formal consultation concludes at the end of the 90 days, unless the consultation period is extended by mutual agreement with the federal action agency and the USFWS.

The Recovery Process

Recovery is the process by which the decline of an endangered or threatened species is stopped or reversed (and threats to its survival are removed so that its long-term survival in nature can be assured). The primary goal of this process is the maintenance of secure, self-sustaining wild populations of species to the point where they no longer require the protection of the Endangered Species Act.

The steps in the USFWS' recovery program are:

1) Identify those ecosystems and organisms that face the highest degree of threat.

2) Determine tasks necessary to reduce or eliminate the threats.

3) Apply the resources available to the highest recovery tasks.

4) Reclassify and delist the species as appropriate.

The first step in the recovery process is the development of species-specific recovery goals and the identification and ranking of species information and n ment needs in terms of their relative importar timing for recovery. This information is usually se a recovery plan for each listed species.

A recovery plan delineates, justifies, and schec research and management actions necessary to recovery of a species, including those that (if suc are likely to permit reclassification or delistin species. These recovery plans are comprehensi ments that identify all known recovery actior species and associated costs by all cooperatin cies. They serve as a blueprint for private, fede state interagency cooperation in the implement recovery actions.

Coordination among federal, state, and local a academic researchers; conservation organizati vate individuals; and major land users is perhaps t essential ingredient for the development and im tation of an effective recovery program. In its coordinator of the recovery process, the USFW emphasize cooperation and teamwork among all i parties.

The recovery planning process provides oppo for public participation, since commitments and ships from various segments of society are rec order for the process to succeed.

Appendix 2

State Listed Endangered and Threatened Species

In 1985, the Oklahoma Wildlife Commission was empowered to create and maintain a list of Oklahoma's endangered and threatened species. Species which may be considered for state listing are those native species which reproduce, migrate, or overwinter in Oklahoma.

To be included on the state endangered species list, a native species' prospect for survival in Oklahoma must be in extreme jeopardy. A state threatened species is a native species that is not currently in danger of extirpation in Oklahoma, but is likely to become endangered or threatened in the foreseeable future if special protection and management efforts are not implemented.

The following species have been listed as state endangered and state threatened by the Oklahoma Wildlife Conservation Commission:

State Endangered
Cave crayfish (*Cambarus tartarus*)
Neosho mucket (*Lampsilis rafinesqueana*)
Longnose darter (*Percina nasuta*)

State Threatened
Arkansas River shiner (*Notropis girardi*)
Blackside darter (*Percina maculata*)

Federally listed endangered or threatened species are automatically included on Oklahoma's state list in the same category.

For further information on state listed species, please contact:

Oklahoma Department of Wildlife Conservation
1801 N. Lincoln, P.O. Box 53465
Oklahoma City, Oklahoma 73152
Phone: 405-521-3851.

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Oklahoma's

NATIONAL REGISTER HANDBOOK

State Historic Preservation Office
2704 Villa Prom, Shepherd Mall
Oklahoma City, Oklahoma 73107

DECEMBER 1996

Hugo:
Hugo Armory [WPA Public Buildings, Recreational Facilities & Cemetery Improvements in Southeastern Oklahoma, 1935-1943 TR], Jefferson & 3rd, 9/8/88, A,C, 88001378.
Hugo Frisco Railroad Depot, North "A" & Jackson, 6/6/80, A, 80003259.
Hugo Historic District, US-70 & US-271, 11/12/80, A, 80003260.
Hugo Public Library [WPA Public Buildings, Recreational Facilities & Cemetery Improvements in Southeastern Oklahoma, 1935-1943 TR], East Jefferson, 9/8/88, A,C, 88001379.
Hugo vicinity:
Everidge Cabin & Cemetery, off Rural Route, 3/31/82, A,C,d, 82003674.
Speer School [WPA Public Buildings, Recreational Facilities & Cemetery Improvements in Southeastern Oklahoma, 1935-1943 TR], off US-271 East, 9/8/88, A,C, 88001380.
Spencerville vicinity:
Spencerville School Campus [WPA Public Buildings, Recreational Facilities & Cemetery Improvements in Southeastern Oklahoma, 1935-1943 TR], South of Spencerville, 9/8/88, A,C, 88001381.
Swink vicinity:
Chief's House, 1½ miles NE of Swink, 6/21/71, A, 71000660.

Cimarron County (Code 025)

Boise City:
Cimarron County Courthouse [County Courthouses of Oklahoma TR], Cimarron Avenue, 8/23/84, A,C, 84002988.
Boise City vicinity:
Autograph Rock Historic District [Santa Fe Trail MPS], Address Restricted, 4/21/94, A, 94000318.
Cold Spring & Inscription Rock Historic District [Santa Fe Trail MPS], Address Restricted, 4/21/94, A, 94000317.
Felt vicinity:
Cedar Breaks Archaeological District (34-CI-193, 34-CI-194, 34-CI-195), Address Restricted, 10/10/78, D, 78002222.

Kenton vicinity:
Bat Cave Archaeological Site (34-CI-69), Address Restricted, 9/1/78, D, 78002223.
Red Ghost Cave Archaeological District (34-CI-39, 34-CI-68), Address Restricted, 11/15/78, D, 78002224.
Three Entrance Cave Archaeological District (34-CI-184, 34-CI-185), Address Restricted, 11/29/78, D, 78002225.
Wheeless vicinity:
Camp Nichols, 3 miles NE of Wheeless on Ranch Road, 10/15/66, A, NHL, 66000628.

Cleveland County (Code 027)

Moore:
Moore Public School Building, NW 1st & Broadway, 11/8/84, A, 84000379.
Norman:
Beta Theta Pi Fraternity House, The University of Oklahoma, 800 South Chautauqua Avenue, 6/2/82, C, 82003675.
Casa Blanca (Alpha Chi Omega Sorority House), 103 West Boyd, 2/21/90, C, 90000123.
DeBarr Historic District, roughly bounded by Boyd, DeBarr Avenue, Duffy & the AT&SF Railroad Tracks, 12/27/91, A,C, 91001904.
Gimeno, Patricio, House, 800 Elm, 12/30/91, C, 91001902.
Jacobson, Oscar B., House, 609 South Chautauqua Avenue, 12/23/86, B,C, 86003466.
Moore-Lindsay House, 508 North Peters, 11/14/85, C, 85002788.
Norman Historic District, 105 West Main & 100-232 East Main, 10/10/78, A,C, 78002226.
President's House (Boyd House), The University of Oklahoma, 407 West Boyd, 7/6/76, A, 76001558.
Santa Fe Depot, Jct. of Abner, Norman Drive & Comanche, 1/25/91, A,C, 90002203.
Sooner Theater Building, 101 East Main, 8/31/78, A,C,g, 78002227.
Stella vicinity:
Mardock Mission, SE of Stella off OK-9, 3/14/83, A, 83002081.

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VIA FACSIMILE

Robert L. Martin, Ph.D.
Division of Petition Control, HFS-215
Office of Premarket Approval
Center for Food Safety and Applied Nutrition
1110 Vermont Avenue - 12th Floor
Washington, D.C. 20005

Re: Food Additive Petition No. 8A4568; Our File No. BI11185-02

Dear Dr. Martin:

Following up on your recent telephone conversations with Tonye Epps of our office, and in accordance with your instructions, we are enclosing a copy of the list of references noted in the Environmental Assessment (EA) submitted in support of the above-referenced food additive petition. As you will see, the list, entitled "14. References," provides a description of each resource material cited in the EA.

We trust that with the submission of this information, FDA will be in a position to proceed expeditiously to complete this matter. Of course, if you have any questions concerning this letter or its enclosure, please do not hesitate to contact us by telephone so that we may respond promptly.

Very truly yours,

John B. Dubeck

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